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The Valier-Montana Irrigation Project

By Kenneth A. Heron*

The irrigation project of the Valier-Montana Land & Water Co. is the largest private and Carey Act project in Montana. It is situated in Teton County, in the northwestern and central part of the state, near Conrad (see map, Fig. 1). The tract lies in a gently rolling, prairie-like country, clear of brush and trees, and drains in a northeasterly direction, with a grade of about 20 ft. per mi., to the Marias River. The altitude of the irrigable land is between 3400 and 3900 ft. (U. S. G. S.).

The soil throughout the project is fertile and deep beyond all practical requirements. Canal excavations and wells dug show that in places it attains a depth of nearly 80 ft. It consists of heavy loam in which the proportion of lime is large and clay small. It is easily worked after first breaking and holds water well. Owing to the arid climate, the soil is unbleached and unwashed and has retained an abundance of soluble salts.

The precipitation over the territory covered by the system amounts to from 6 to 8 in. during the growing season, and from 10 to 12 during the remainder of the year, and while some good results have been obtained by growing winter grains in this locality, the extra cost of the construction of the irrigation works has been more than justified by the increase and variety of crops that are now grown and irrigated. Alfalfa is rapidly becoming a staple crop and although the season is comparatively short, some of the yields obtained compare favorably with those of the more southerly states.

Site of Swift Dam on Birch Creek, Valier-Montana Irrigation Project

Besides alfalfa, the predominating crops are wheat, barley, oats, flax, potatoes, rye and garden truck. No lands in the project are more than 12 miles from a railroad and approximately 85% are within six miles, either of the Great Northern R.R., which runs through the southern part of the irrigation system, and also forms the eastern boundary, or the Montana Western Ry., which traverses the center of it. The towns of Conrad and Fowler on the Great Northern, and Manson, Williams and Valier on the Montana Western, are shipping points. From these, roads extend to all parts of the system.

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Lands in Project

The total acreage within the boundaries of the project is 200,000, classed as follows:

	Irrigable	Non-irrigable	Total
Carey Act lands	76,814	8,683	85,497
Company and private lands in the project	38,286	7,174	45,460
Private lands not included in the project	36,366	32,677	69,043
Total	151,466	48,534	200,000

At the present time approximately 30,000 acres of Carey land has been settled upon; 11,000 acres of private lands in the project are in small holdings and 28,000 acres of company lands have been sold. When it is considered that five years ago this whole country was open range, this speaks well for the enterprise and management of the project.

Water-Supply

The water-supply for irrigation is derived mainly from Birch Creek, a mountain stream flowing the year around from the east slope of the Rockies and of excellent quality. This creek drains an area of 185 sq.mi. above the intake of the Birch Creek Canal. For the purpose of storing the winter flow and excess summer flood water, the company is constructing a rock-fill dam 165 ft. high at the point where the creek leaves the mountains. The reservoir thus formed will have a capacity of 30,000 acre-ft., and is relied on to make available for irrigation the total flow of the creek. The flow of Birch Creek is supplemented by the flow of Dupuyer Creek, which has a foothill drainage area of 111 sq.mi. The waters of Birch Creek are diverted into the Birch Creek Canal at a point 12 mi. below the Swift Dam. From that point the canal runs easterly 14 mi., with a carrying capacity of 700 cu. ft. per sec. It empties into Dupuyer Creek at a point a short distance above the headgates of the Dupuyer Creek Canal. This canal has a carrying capacity of 900 cu.ft. per sec. and diverts flood waters from Dupuyer Creek to that extent.

acres of Carey Act, company and private lands deri their water-supply from this reservoir, and 45,000 acr will be watered by the direct flow of Birch and Dupuy Creeks and the Birch Creek Reservoir, together with portion of the top water of the Lake Francis Reservoir A duty of 18 in. or 1½ acre-ft. per acre has been est mated as the probable water requirement, and the co tract between the state and the company specifies that t canals and reservoirs shall be of sufficient size to supp this amount of water to the lands. Inasmuch as exper ments conducted in the vicinity of Billings, particularl on the McDonnell Farm, have shown that a duty of 1. acre-ft. per acre is ample for alfalfa, there is every rea

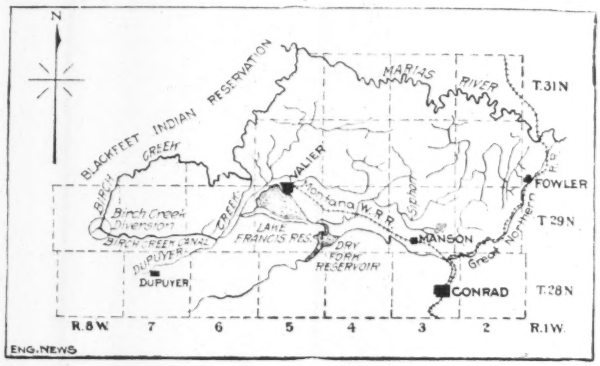


Fig. 1. Map of Valier-Montana Irrigation Project

son to believe that the water-supply and the capacity of the irrigation works is more than sufficient to take care of the future needs of the project.

Swift Dam and Birch Creek Reservoir

The Swift Dam is located in a narrow cañon (see front-page view) at a point where Birch Creek leaves the mountains, about 35 mi. southwest of Valier. The reservoir covers an area of 455 acres and has a capacity of 31,355 acre-ft. The drainage area above the dam is 120

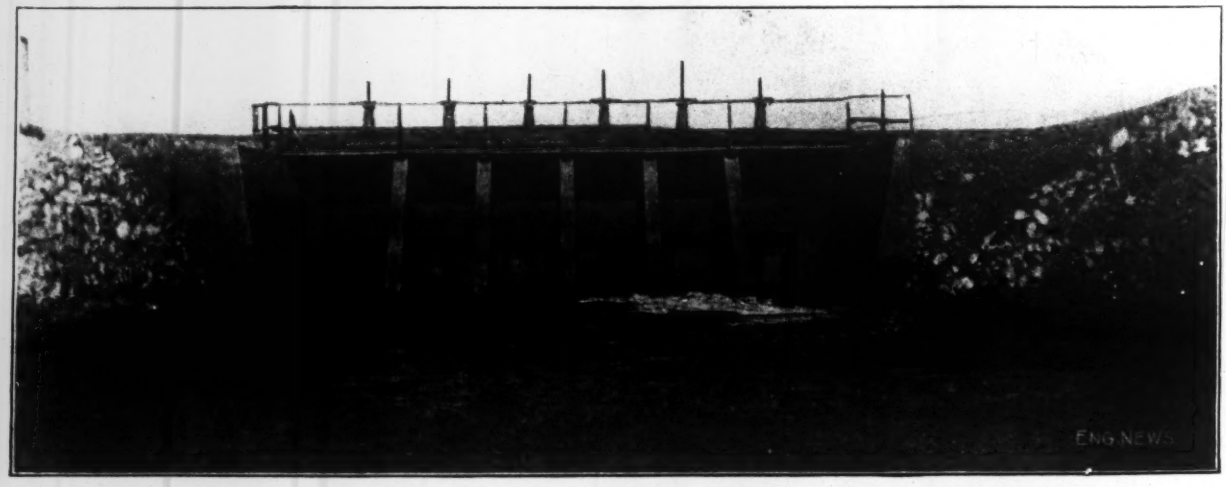


Fig. 2. Birch Creek Headgates, Looking Upstream

The Dupuyer Creek Canal is about three miles long and carries its waters either to the main distributing canal or to the Lake Francis Reservoir. The latter covers an area of 5536 acres and will have a capacity of 112,000 acre-ft. storage when completed. About 70,000 sq.mi. and it is estimated that the reservoir will be filled twice yearly and conserve the entire flow of the stream above this point. This dam is the most important structure on the project and is one of the highest rock-fill dams in the country, the maximum height being 165 ft.

The dam in section has an upstream slope of 1 to 1, a 15-ft. crown and a downstream slope of 1¼ to 1 for the top 50 ft. and 1½ to 1 on the lower portion. The upstream face of the fill is covered with a layer of hand-placed rock from 4 to 6 ft. thick. The face of this hand-placed rock is plastered with a cement mortar to form a smooth surface. This is coated with a tar preparation, and on the tarred surface is placed a concrete slab, heavily reinforced, which has a thickness of 2 ft. at the creek-bed elevation and will be 6 in. thick at the top of the dam. The reinforcement consists of ½-in. twisted bars placed 4 in. c. to c. horizontally and vertically. The dam is built on a curve whose center is 1276 ft. downstream. The relating structures consist of an outlet tunnel, overflow spillway and rock-and-earth-fill dike. The tunnel is about 500 ft. long, with an inside area of 39 sq.ft. and is concrete lined throughout. The intake end is bell-shaped and is protected by a heavy iron screen. The regulating works consists of four 36-in. valves on the discharge end. These valves are bolted to a 7-ft. steel pipe of ½-in. plate, which is inserted 100 ft. into the lower end of the tunnel and concreted in. The valves discharge at right angles to the pipe.

The spillway consists of a weir 400 ft. in length at an elevation of 147 ft. above the base of the dam. The weir discharges into a concrete-lined channel with a base width of 18 ft., and a maximum water depth of 20 ft. It is estimated that the structure has a capacity of 10,000 sec.-ft., or nearly three times the maximum flood recorded.

The dike consists of a fill of earth and rock about 40 ft. high and 400 ft. in length. The reservoir side of the dike consists of earth fill and has a slope of 3 to 1. The earth is banked against a rock fill on the downstream side. The outer slope of the rock is 1½ to 1. The top width of the entire dike is 20 ft., of which 15 ft. is earth and 5 ft. rock. The upstream side of the rock has a slope of ¾ to 1. A concrete cutoff wall extends the length of the earth fill and serves to insure a joint between the fill and the original ground. The water side of the structure is riprapped with rock 12 in. thick.

Preliminary work at the dam site showed that on the center line of the dam the creek deposit of sand, gravel and boulders attained a maximum depth of 17 ft. During construction, however, considerable difficulty was encountered, owing to the fact that at the site of the cutoff or toe wall, which was 150 or 200 ft. upstream from the test borings, it was necessary to excavate to a depth of nearly 35 ft. The work was slow and while most of the creek water was diverted through the tunnel during this work the seepage through the gravel bed amounted to considerable and necessitated constant pumping.

FIG. 4. VIEW OF OUTLET OF BULL HEAD PIPE LINE DROP

(This drop consists of 1800 ft. of 48-in. reinforced-concrete pipe, falling 40 ft. It reduces the velocity from 15 to 2 ft. per sec.)

The size of the toe-wall trench at the time of placing the first concrete in it was 35 ft. deep, 16 ft. wide,

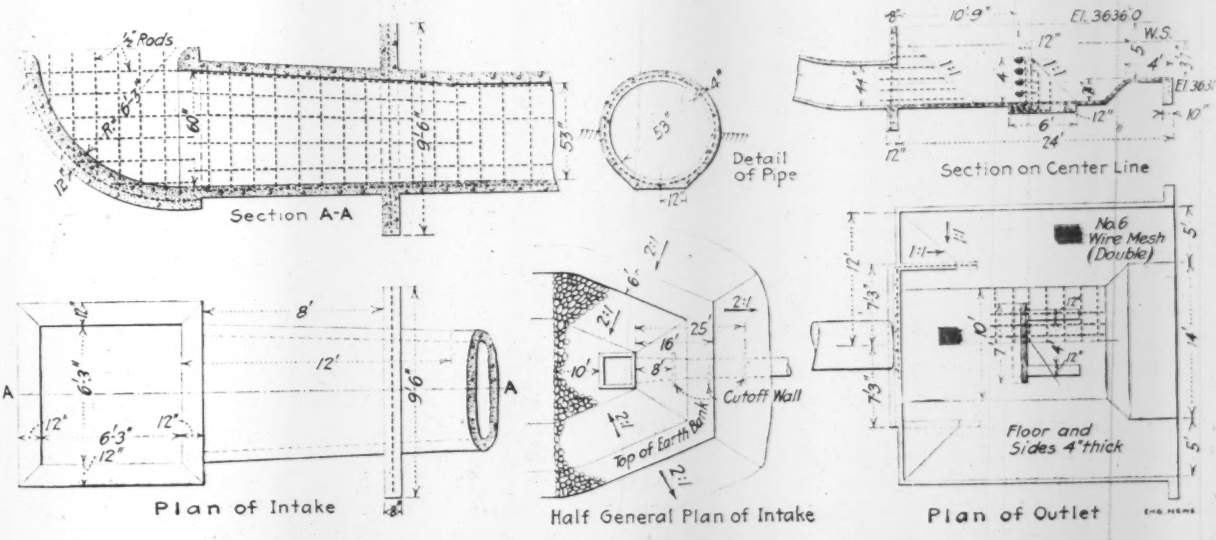


FIG. 3. DETAILS OF REINFORCED-CONCRETE PIPE DROP IN A_N CANAL

80 ft. long on top and 40 ft. on the bottom. Considerable concrete had been placed in the trench when in the latter part of May a flood came down the creek and covered the work to a depth of 30 ft. On the fall of the water it was found that practically all the concrete that had been placed was spoiled and had to be removed as a result of being washed of the cement. This was done, and from that time until cold weather in the fall of 1913, the work on the concrete face progressed steadily. At the present time the dam is practically complete with the exception of the upper portion of the concrete slab.

Lake Francis Reservoir

The Lake Francis Dam, although impounding much more water than the Swift Dam, is an ordinary earth structure. It was originally constructed about ten years ago by the Poudera Canal Co., a small company which was later absorbed and merged into the present water company. A heavy double-barred outlet culvert was built through this structure with quicksand underneath and insufficient piling to hold it. As a result, settlement of portions of the culvert and core wall caused serious damage. It was repaired in 1912 at an expense of about $35,000 and raised several feet.

The reconstructed dam consists of an earth fill with a maximum height of 60 ft. and length of 600 ft. on top. The upstream side has a slope of 1½ to 1 and is rock riprapped. The top width is 20 ft. The upper portion of the downstream slope is 2 to 1 and lower portion 3 to 1.

a minimum capacity of 5 sec.-ft. The settler's contra with the company provide that the latter construct a la eral to within ½ mi. of each legal subdivision of i land. This has resulted in the whole area being practi ally covered to such an extent as to enable the canal to deliver water to any part of it. In the 477 mi. o canals and laterals that have been constructed, almo every imaginable design of canal section is represente The general nature of the material (sandy loam) through which the smaller canals and laterals were located led to an almost universal design of section in which the value of n was assumed to be 0.0275; water depth very close to three times the bottom width; height of bank 1½ times the depth of the water, but seldom less than 2 ft.; crown width equal to height of bank, but not less than 3 ft.; minimum velocity, 1 ft. per sec.; maximum velocity, 2½ ft. per sec.; slopes, 2 to 1, except in deep

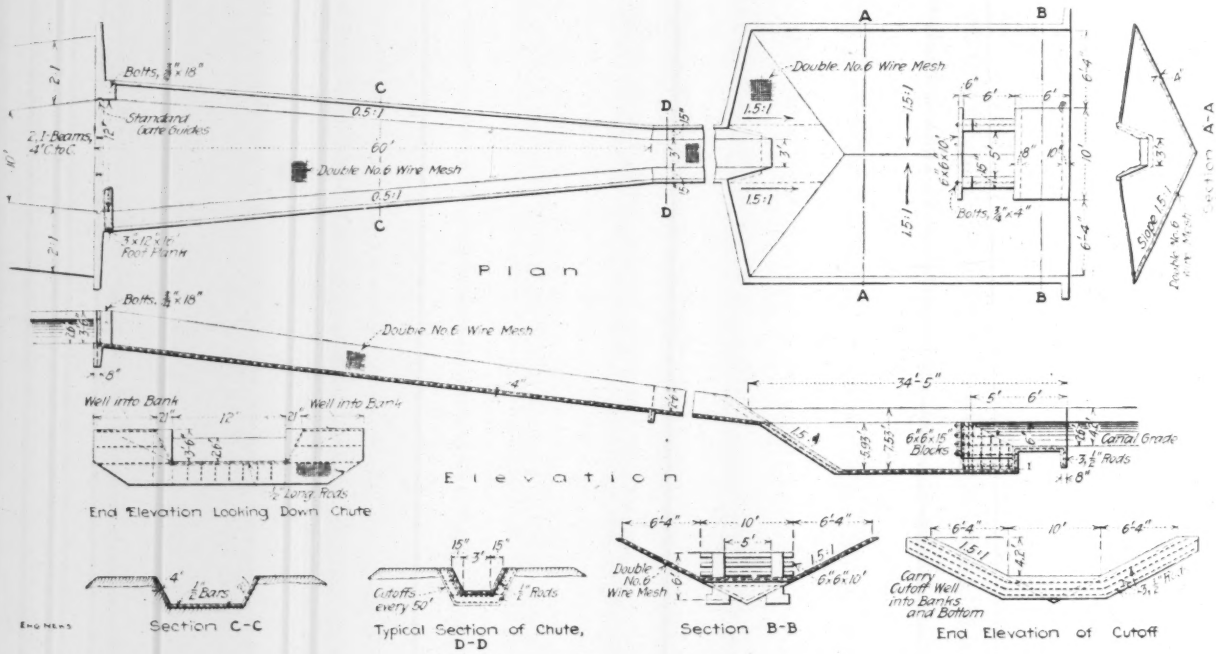


Fig. 5. Details of Concrete Chute on K Canal

A concrete core wall 12 in. thick at the top and 4 ft. at the bottom extends throughout the entire fill and rests on steel sheet piling in the bottom. The discharge from the reservoir is through two 53-in. concrete culverts and is regulated by two 48-in. Coffin valves. The culverts merge into one 7-ft. pipe at the lower end of the structure. The reconstruction work necessitated the abandonment of the original valve tower and the construction of a new one.

On the completion of a dike at the upper end of the reservoir, the storage capacity will be 112,000 acre-ft. and the area submerged, 5536 acres.

Headgates and Distributing System

The distribution of water over the tract has required the construction of 153 mi. of main laterals of capacities ranging from 600 to 50 sec.-ft. and 274 mi. of distributing laterals with capacities of from 50 to 5 sec.-ft. Each canal and lateral is designed with a carrying capacity of 1 sec.-ft. for each 100 acres of land covered by it and

cuts. For some of the larger canals, having gravel sides and bottoms and irregular sections, a value of n equal 0.030 was used.

Birch Creek Diversion Dam and Headgates—This structure (Fig. 2) is located on Birch Creek about 12 mi. below the Swift Dam. In consists of a massive concrete headgate structure and diversion dam across Birch Creek.

Dupuyer Creek Headgates and Diversion Dams—A diversion weir reaches across Dupuyer Creek at the intake of the Dupuyer Canal. The weir will pass the heaviest floods, and the intake has a capacity of 900 sec.-ft. The whole structure is solidly built of reinforced concrete.

Pipe-Line Drops and Chutes—Owing to the rapid fall of the country to the north and east, a number of drops and chutes have been constructed to deliver water to canals at lower elevations. As a rule, pipe lines of reinforced concrete have been used when the quantity of water and size of the pipe would warrant this type of structure. Nine of these pipe-line drops have been con-

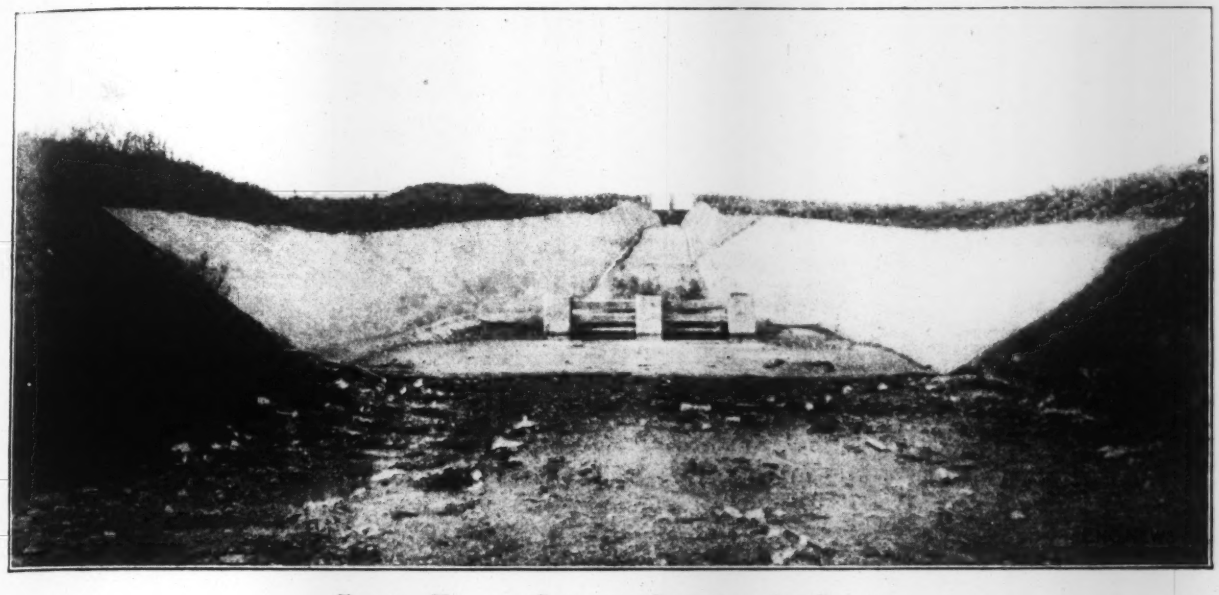


FIG. 6. VIEW OF CONCRETE CHUTE ON A_N CANAL
(This chute has a capacity of 300 cu.ft. per sec.)

structed of monolithic reinforced-concrete pipe. The largest (Fig. 3) is 53 in. internal diameter and 2200 ft. long, with carrying capacity of 270 sec.-ft. Others range in size from 36 to 53 in. and from 200 ft. to 1800

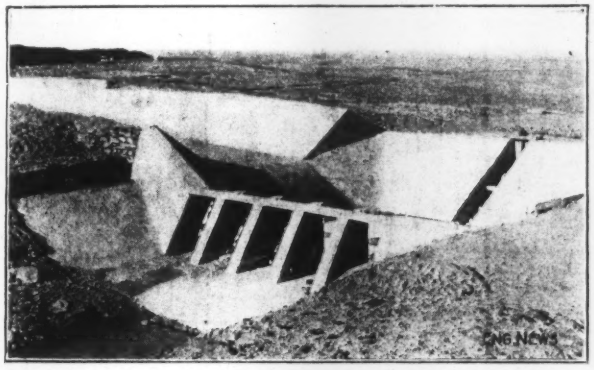


FIG. 7. MASSIVE CONCRETE DROP AND CHUTE ON CANAL C
(Capacity, over 500 cu.ft. per sec.)

ft. in length. Fig. 4 shows the outlet of one of these drops. This type of structure, with properly designed intake and outlet, has proved very successful.

Several concrete chutes have been constructed for the same purpose. The largest of these has a capacity of over 600 sec.-ft. and is approximately 1500 ft. in length. It has been in operation for three years and although on a very steep grade and the water in it attains velocities as high as 20 ft. per sec., it shows no sign of wear. Fig. 5 shows the details of a chute on the K canal and Fig. 6 is a view of a chute on the A_n canal. A drop and chute on canal C is shown by Fig. 7.

BIG FLAT COULEE SIPHON—This is an inverted siphon consisting of 1000 ft. of concrete pressure pipe 7 ft. in diameter and 3000 ft. of wood-stave pipe 78 in. in diameter, with intake and outlet structures. The concrete pipe is under a maximum head of 20 ft. and the wood-stave pipe at its lowest point is under a head of 165 ft. The carrying capacity of the siphon is 375 sec.-ft. Big Flat Coulee is a deep depression running generally north and south through the project and cuts off about one-

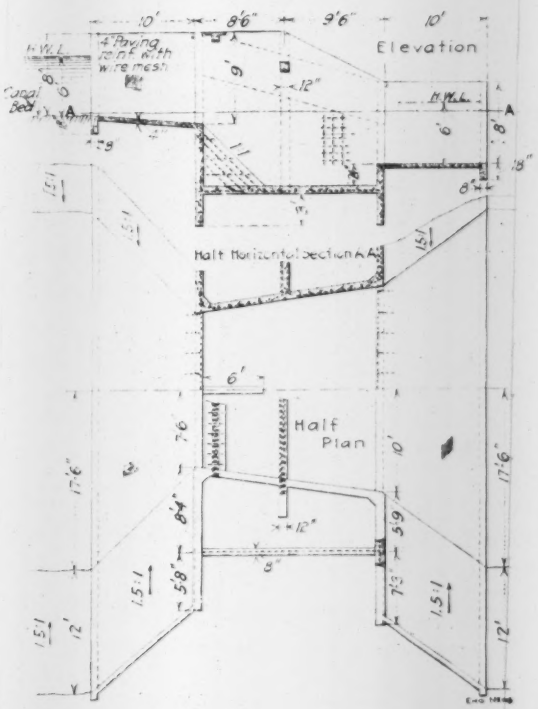


FIG. 8. DETAILS OF 5-FT. CONCRETE DROP ON IRRIGATION CANAL

third of the whole area. The siphon conveys the water for 37,500 acres over this coulee.

BIRCH CREEK CANAL DROPS—Two reinforced-concrete drops have been constructed on this canal. One (Figs. 7 and 8) has a vertical fall of 5 ft., and the other a 12-ft.

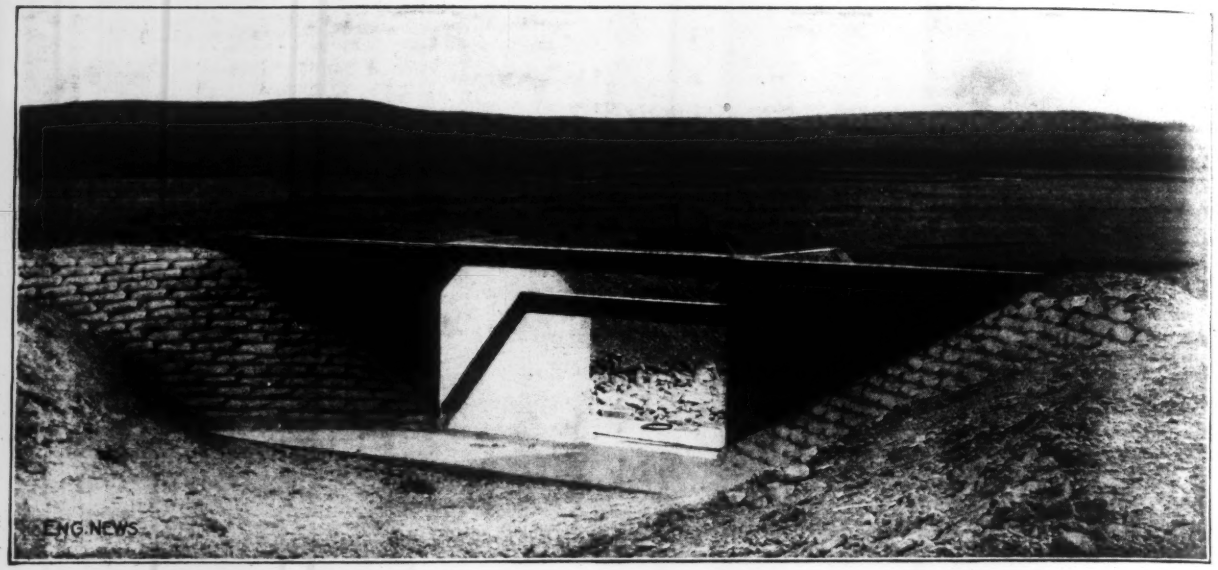


FIG. 9. UPSTREAM VIEW OF CONCRETE DROP IN BIRCH CREEK CANAL
(Capacity, 700 cu.ft. per sec. Riprap consists of concrete in sacks)

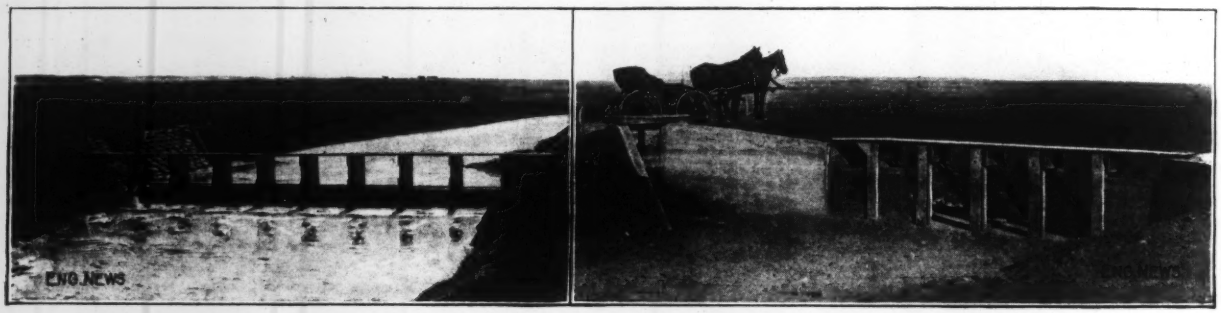
drop. Both structures are designed for a capacity of 700 sec.-ft. About 80 ft. of excess grade is taken care of by about 35 timber and concrete drops. These drops consist of heavy timber aprons and floors with sacked concrete wing walls. The vertical fall in each is about 2½ ft. Six of these drops have been constructed in the Dupuyer Creek Canal for the same purpose.

HEADGATES AND OTHER STRUCTURES—All distributing canal structures are constructed of reinforced concrete. This applies to canals and laterals with capacities of over 60 sec.-ft. Where the capacity of the laterals is less than 60 sec.-ft., structures are constructed of timber, except in the case of drops. These are generally of concrete where the canal capacity is more than 20 sec.-ft.

A check and turnout in the main canal is shown by Fig. 10 and another check and turnout by Fig. 11.

Timber has been used in constructing all small lateral structures and bridges over main canals. About 400 bridges of spans from 8 to 64 ft. have been placed over canals where crossed by roads. These are substantially built and designed for a load equal to a 20-ton traction engine. Prior to the irrigation season of 1914 over 1200 timber checks, drops, diversion boxes and rating flumes had been placed.

Prior to June, 1911, the property was controlled by the Conrad Land & Water Co., for which H. J. Saunders was Resident Engineer. Ford, Bacon & Davis, 115 Broadway, New York City, then became engineers and the Valier-Montana Land & Water Co. was organized to complete the system. Until December, 1911, J. G. Holcombe was in local charge of the work. Since December, 1911,



FIGS. 10 AND 11. TYPICAL CHECKS AND TURNOUTS

W. E. Swift has been Engineer-in-Charge for Ford, Bacon & Davis, except that from March to June, 1913, L. L. Odell served as Resident Engineer. The writer was Designing Engineer and in charge of the Valier office from August, 1911, until June, 1913.

The Gladstone Dry Dock at Liverpool, one of the largest dry docks in the world, has its pumping plant driven by Diesel oil engines. The dock is 1050 ft. in length, and on an 18-ft. tide 7,000,000 cu.ft. of water must be handled in order to empty it. The pumping plant is capable of removing this water in 2½ hours, or at the rate of 1300 tons per minute. The pumping plant consists of five centrifugal pumps with 54-in. discharge pipes, each pump being directly coupled to a four-cylinder two-stroke-cycle Diesel engine of 1000 b.hp. built by Carels Bros., of Ghent. The advantage of the oil engine for this work is that the plant is always ready for immediate use without waiting to get up steam and without the heat losses which occur in firing up a steam plant for a short period of service. From the financial point of view, however, the oil-engine plant is much more costly per horsepower to install than a steam plant would be, and a dry-dock pumping plant is in use such a small percentage of the time that the amount of fuel consumed during its working hours is of trifling importance.

Specifications for Concrete Aggregates and Results of Field Tests

By Ralph E. Goodwin*

SYNOPSIS—Continuation of paper by same author in issue of Feb. 4, 1915. First paper gave standard practice in testing concrete aggregates and field specimens of concrete for all of the new subway extensions in New York City. This paper gives specifications for concrete aggregate and reasons for their adoption and a tabular analysis of a series of field tests of concrete. This latter shows variation in strength due to different causes.

This article proposes to give (1) the requirements adopted by the Public Service Commission for quality of concrete aggregates used in subway construction, New York City, including a study of the methods used in arriving at these requirements, and (2) results of field tests of concrete.

1. Specifications for Aggregates

Fine Aggregates—The contract specifications require that fine aggregate for concrete shall be "clean sand, approved by the engineer." With these requirements as a basis it is left to the Division of Materials Inspection to recommend what shall be approved. The following proposed standards are the result of investigations made by this Division for the purpose of reducing inspection to a scientific basis.

Fine aggregate for concrete shall conform to the following requirements:

Mechanical Grading—

Size of Opening (Square Holes)	Commercial Number of Sieve	Limit of Fineness (% Passing). Not More May Pass	Limit of Coarseness (% Passing). Not Less Must Pass
0.20	4	100	95
0.10	8	95	85
0.042	16	75	40
0.021	30	50	20
0.011	50	30	2
0.006	100	6	..

Silt—Not over 6% by dry weight shall pass a No. 100 sieve when screened dry. Not over 10%, dry weight, shall pass a No. 100 sieve when washed on the sieve with a stream of water.

Both of the above tests shall be made, and neither limit shall be exceeded.

The following test is for field use only:

Not over 10% by volume shall be silt when the test is made by decanting from test tubes, as described in "Standard Practice Instructions" ("Engineering News," Feb. 4, 1915).

Strength in Mortar—Fine aggregate shall be of such quality that mortar composed of one part portland cement and three parts fine aggregate by weight will show a tensile and compressive strength at least equal to the strength of 1 : 3 mortar of the same consistency made with the same cement and standard Ottawa sand. Fine aggregate shall not be dried before being made into mortar, but shall contain natural moisture.

Organic Matter—Loss on ignition shall not exceed 0.1% of the total dry sand by weight, nor 10% of the silt obtained by decantation, as described in "Standard Practice Instructions."

These specifications were prepared as a result of investigations which may be abstracted as follows:

Mechanical Grading—These figures set a limit of fineness and a limit of coarseness which may not be exceeded.

With reference first to the limit of fineness: The 6% passing the No. 100 sieve is the recommendation of the Joint Committee on Concrete and Reinforced Concrete in its most recent report. The 30% passing the No. 50 sieve is a compromise between the statement in Merriman's "Pocket Book" that not over 30% should pass a No. 40 sieve and the statement in "Concrete Plain and Reinforced," Taylor and Thompson, that not over 35% should pass a No. 50 sieve. The 50% passing the No. 30 sieve is obtained from "Concrete Plain and Reinforced." The remaining figures are assumed in such a way as to produce a well graded sand with a graph of the same general shape as the curve for maximum density, and of which 100% will pass a No. 4 sieve (corresponding to the ¼-in. round-hole sieve required by the Joint Committee). Table I gives results of compressive tests of 2-in. cubes made of sands of different degrees of fineness and shows that the limit of fineness adopted produces a sand whose strength in mortar is very nearly the same as that of Ottawa sand.

A limit of coarseness is specified because it has been found that certain plants which have a separate market for fine sand, desire to furnish a very coarse sand for concrete. A very coarse sand will not make cohesive concrete, and concrete made from such sand suffers from separation of the coarse aggregate from the mortar. In the early days of the investigation the curve of ideal proportions for concrete was used as a basis from which to derive a curve to represent the ideal grading of fine aggregate for 1 : 2 : 4 concrete. (See "Concrete Plain and

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TABLE I—COMPRESSIVE STRENGTH AND ELEMENTARY VOLUMETRIC COMPOSITION OF MORTAR MADE FROM COMMERCIAL SANDS

(The compressive specimens were 2-in. cubes of normal consistency. These results are typical of a large number of tests.)

Sand	Proportions by Dry Weight	Mechanical Grading — Per Cent. Passing — Number of Sieve: 4	8	16	20	30	50	100	Elementary Volumes: Cement C	Sand S	Density C + S	$\left\{\frac{C}{1-S}\right\}^2$	Per Cent. of Strength of Ottawa Sand Age 7 Days	Per Cent. of Strength of Ottawa Sand Age 28 Days	Number of Specimens Averaged in Each Result
Sample No. 73	1 : 3	98	91	67	...	30	12	4	0.152	0.535	0.69	0.107	104	111	3
Limit of fineness..	1 : 3	100	95	75	...	50	30	6	0.150	0.558	0.71	0.115	108	115	3
Ottawa sand	1 : 3	...	...	...	100	00	...	..	0.158	0.553	0.71	0.125	100	100	3
Sample No. 77	1 : 3	99	97	85	...	42	10	2	0.149	0.530	0.68	0.101	84	92	3
Sample No. 63	1 : 3	100	100	99	...	92	63	25	0.136	0.477	0.61	0.068	41	58	3

Reinforced," Taylor and Thompson, p. 183.) But experiment with such a sand showed that its coarseness makes it impracticable. The limit of coarseness finally adopted was arrived at by making up artificially graded samples of different degrees of coarseness, and by inspection selecting one as a limit of coarseness. Hence the limit of coarseness is not recommended as a rigid requirement, but it may be used as a guide to be modified by local conditions. The graph of the limit of coarseness has the same general shape as the curve for maximum density.

Silt—The requirement that not over 6% shall pass a No. 100 sieve dry has been discussed above. The additional requirement that not over 10% shall pass a No. 100 sieve by washing is an arbitrary one, although it is the same figure specified in the earlier reports of the Joint Committee for the maximum permitted to pass the No. 100 sieve dry. The purpose of the requirement is to limit the amount of clay which may adhere to the grains of sand and which only washing will remove.

The requirement for field tests is somewhat more severe than the one for laboratory tests, as can be seen from Table II. It is thought desirable that this should be

TABLE II—DETERMINATION OF SILT IN FINE AGGREGATE BY DIFFERENT METHODS

(Note the wide variation between gravimetric and volumetric results. The volumetric method is uncertain, being affected by the character and specific gravity of the silt.)

Sample Number	Per Cent. Passing No. 100 Sieve Dry. (By Weight)	Per Cent. Passing No. 100 Sieve. (Washing Test) By Weight	Per Cent. by Decanting. (Volumetric) For Field Use Only	Per Cent. by Decanting. (By Weight)
148	5	10	14	...
149	6	8	16	...
150	8	10	13	...
156	31	32	26	...
157	31	31	15	...
158	2	3	12	...
A	2	3	8	0.5
B	2	5	8	1.0
C	5	7	11	2.0
D	6	8	10	1.0
49	5	9	25	...
159	5	6	12	...
160	2	2	12	...
166	6	6	...	...
169	5	10	22	...
192	2	2	12	...

the case, since sands of doubtful quality should be sent to the laboratory for careful examination. After the results of the laboratory tests are known, the results of the field tests are disregarded.

A knowledge of the mechanical analysis and silt content of a fine aggregate are sufficient data on which to base a preliminary report, as an aggregate which conforms to the requirements in these respects will be almost certain to be satisfactory, provided that it contains no harmful impurities.

Strength in Mortar—The Joint Committee recommends that fine aggregate shall make mortar of as great a tensile strength as Ottawa sand mortar. The Public Service Commission requirement is based on this recommendation, and was adopted after it had been demonstrated that fine aggregate of good quality will make mortar equal to Ottawa sand mortar in both tensile and compressive strength.

This test is considered the most important of any. If the aggregate passes it, the results of the other tests may be more or less disregarded. Variation in the consistency of specimens greatly affects the strength at early periods, and to allow for this effect the following variations below standard are permitted: At 3 days, 10%; at 7 days, 5%; at 28 days, 1%.

In general, it may be said of two sands that the one which makes the heaviest cubes will also make the strongest. But this theory is far from being dependable, and it does not follow from it that the heaviest cube of a number made from the same sand will be the strongest. Two opposed factors enter into the case. So far as increase in weight indicates a decrease in voids, the strength will be increased. But, on the other hand, an increase in weight may indicate an excess of aggregate to the exclusion of cement, the specific gravity of aggregate being about 2.65, while the specific gravity of 1:3 mortar (by weight) of wet consistency is never over 2.3. The effect of this will be a decrease in the strength of specimens. Hence it is impossible to predict the strength of a specimen from its weight. Fig. 1 shows the general increase of strength with weight, but also shows the wide variation in individual cases which would be expected from the theory outlined above. The following figures are of interest as showing that the heaviest of a set of specimens made from the same sand is not the strongest. The specimens were the same as are represented in a different way in Fig. 1.

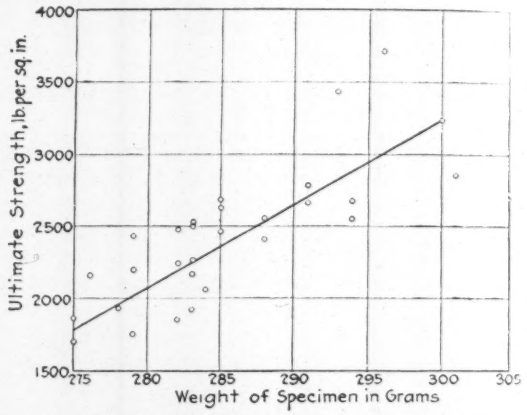


FIG. 1. INCREASE OF STRENGTH WITH WEIGHT OF MORTAR CUBES

In 7 tests the lightest cube was the strongest.
In 9 tests the cube of intermediate weight was the strongest.

Summing up:

In 16 tests the heaviest cube was not the strongest.
In 12 tests the heaviest cube was the strongest.
1 test showed nothing either way.

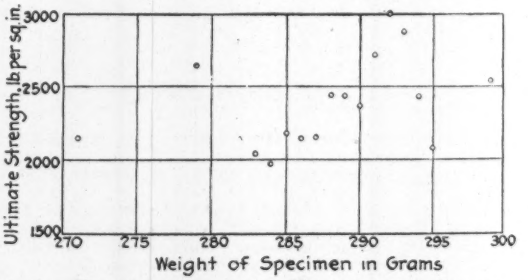


FIG. 2. RELATION BETWEEN WEIGHT AND STRENGTH OF CONCRETE CUBES
(Ottawa sand)

Fig. 2 shows the relation between the weight and strength of Ottawa sand cubes. There are 63 specimens represented, all 28 days old and made with the same cement and under the same conditions as the cubes of Fig. 1. Each point represents the average of all specimens of the given weight.

In order to determine whether or not it is safe to accept a sand submitted for test on the results of the three days' test, the specimens of Fig. 1 were tabulated as in Table III, but with rather unsatisfactory results. A sand is considered satisfactory if its strength in mortar is equal to the strength of Ottawa sand mortar after making the allowances for variation explained above.

TABLE III—2-IN. CUBES OF COMMERCIAL SANDS COMPARED WITH OTTAWA SAND

12 sands were O. K. at 3-day, 7-day and 28-day periods.
2 sands failed at 3-day, 7-day and 28-day periods.
2 sands failed at 3 days, O. K. 7 and 28 days.
5 sands O. K. 3 days, failed 7 and 28 days.
5 sands O. K. 3 and 7 days, failed 28 days.
1 sand O. K. 3 days, failed 7 days, O. K. 28 days.
1 sand failed 3 days, O. K. 7 days, failed 28 days.

Organic Matter—The figures given are taken from "Concrete Plain and Reinforced." As it is seldom necessary to make this test, there is little data on the subject available. But in general it may be said that a sand which very much exceeds the limits stated will also appear dirty and suspicious.

Coarse Aggregates—The contract specifications require that,

The concrete shall be composed of gravel or broken stone, or a mixture of both, free from all dust and dirt. . . . Stone for concrete shall be a sound, clean gravel, or sound, hard, broken limestone or trap rock, or a mixture of such gravel and broken stone. If a mixture of gravel and broken stone is used, the Engineer may require that the gravel and broken stone be stored separately on the work and mixed in single batches as needed. The gravel or broken stone or the mixture of gravel and broken stone shall be graded from fine to coarse, and that which is all of one size, or practically so, shall not be used. It shall be screened or washed so as to remove all dust, and it shall contain no pieces that will pass through a hole ⅜ in. in diameter, and no pieces that will not pass through a hole 1¾ in. in diameter. Broken stone or gravel for concrete, graded as above, but between ¾ and ¾ in. in diameter, may be required for use in special parts of the work.

It is necessary to adhere closely to the limits for maximum size of aggregate, because stones that are oversize are troublesome in thin walls and around reinforcement. On the other hand, the maximum size should be as large as practicable in order to produce the strongest concrete.

On account of the difficulty of obtaining round-hole screens, tests are made with square-hole screens of sizes to correspond to the specification requirements. The following limits are observed:

Mechanical Grading—

Size of Opening (Square Holes) In.	Limit of Fineness (% Passing) Not More May Pass	Limit of Coarseness (% Passing) Not Less Must Pass
2	...	100
1½	100	95
1	80	40
¾	60	25
½	40	10
¼	5	..

Cleanliness—All broken stone aggregates must be so free from dust that samples caught as the material falls from the conveyor belt at the plant will be within the limit of fineness. All gravel must be thoroughly washed at the plant.

These specifications were prepared from the following considerations:

Mechanical Grading—It is considered that the ideal grading is a straight-line analysis from the maximum size of sand to the maximum size of stone, as has been shown by the experiments to determine the ideal proportions of ingredients for concrete previously referred to. The variations permitted from this ideal are such as are necessary to meet practical conditions. It is found that within the limits given the manner in which the coarse aggregate is graded does not appreciably affect the strength of 1:2:4 concrete, the concrete being so rich that the differences in the grading of the aggregates are swallowed up.

2. Results of Field Tests of Concrete

Interesting results of field tests of concrete are given in Table IV. The figures include only tests made under satisfactory conditions in accordance with standard practice. In computing the averages, the result of any test which differed more than 50% from the average was excluded. There were three specimens in each 28-day test and three in each 90-day test. All the tests were made in warm weather and the aggregates were specification materials in every case. All specimens were 8x16-in. cylinders of 1:2:4 concrete made in the field and, in most cases, taken out of the forms after it had been placed in the structure. The figures include tests on 24 different contracts and represent many different combinations of cements and aggregates.

In interpreting the results it is important to remember that a large number of different conditions affect the strength of each test, and although the results in the tables are tabulated in such a way as to make it appear that each was controlled by a single factor, such was not the case. It would be dangerous to draw conclusions from results that are the average of only a small number of tests.

The results of tabulations to show what relations, if any, exist between the weight and the strength of specimens resulted so much the same as similar investigations of the weight of mortar cubes that they are not reproduced. Not even a general increase of strength with weight was shown when specimens made from different aggregates were compared, and among specimens made from the same materials the heaviest was the strongest in not more than 50% of the 25 tests examined.

The results brought out below seem to indicate that the stresses allowed in concrete by the present figures used in design are fully as high as should be allowed, if, indeed, they are not already too high. Conservative engineers should vehemently oppose any proposition to raise them still higher.

TABLE IV—FIELD TESTS OF 1:2:4 CONCRETE IN 8x16-IN. CYLINDERS, MADE BY PUBLIC SERVICE COMMISSION, NEW YORK, FIRST DISTRICT

(The same tests are shown tabulated under different headings to show the effect of various conditions. There were three specimens in each test.)

	28 Days Old		90 Days Old		
	Average Lb. per Sq.In.	Number of Tests Represented in Average	Average Lb. per Sq.In.	Number of Tests Represented in Average	Increase Over Corresponding 28-Day Tests
Average of all tests	1490	48	1840	27	26%
Coarse Aggregate—					
Hudson River trap rock	1660	10	2090	6	17%
Hudson River dolomite	1560	5	1760	5	13%
Long Island bank gravel (washed)	1520	26	1850	17	22%
Long Island beach gravel	1290	7	.....	..	..
Fine Aggregate					
Long Island bank sand (washed)	1540	28	1830	18	18%
Long Island beach sand	1520	9	2180	2	6%
Sand excavated on the work	1470	7	1890	5	28%
Consistency—					
Wet (stiff enough to keep coarse aggregate from settling to bottom)	1970	15	2280	9	8%
Very wet (coarse aggregate settles to bottom)	1420	28	1770	17	21%
Extra wet (soupy)	1120	6	1480	2	15%
Mixer—					
Machine	1580	33	1900	20	15%
Hand	1310	9	1730	7	39%

Locating and Mapping Pipes and Valves on an Old Water-Supply*

By Carleton E. Davis†

The original water-works of Philadelphia were constructed about 1801. The first cast-iron pipe was laid in 1817 and considerable pipe which was in the ground as early as 1820 or 1830 is still doing service in the distributing system. The present city is an amalgamation of a number of distinct municipalities some of which had a water-supply at the time of incorporation with the larger community.

As the city has grown, various water-supply projects have been developed, used, outgrown, and abandoned in whole or in part. During the last fifteen years the introduction of a filtered supply has brought about a radical readjustment of the principal supply mains and a realignment of the distribution districts.

Certain general maps and plans, compiled by William Whitby, of the Bureau of Water, are now being developed and expanded. The scheme provides certain general features:

(1) Data used chiefly for controlling and regulating the amount and pressure of water throughout the system, or in other words, data used in operating the supply. Under this head are maps defining the limits of the several distinct distribution areas, accompanied by data showing the sources of supply for each area and a list of valves controlling the supply; likewise, general maps showing all large mains, reservoirs and pumping stations, together with detail maps of the piping system and operating valves at the pumping stations, filters and reservoirs.

(2) Data used chiefly for repairs and maintenance, including detail maps showing the complete gridiron of distribution pipes on which the location of all valves and hydrants are indicated. Each street intersection is mapped on a separate plan of a size convenient for use in the field.

(3) Data used chiefly for the business relations between the consumer and the Bureau of Water, such as location, depth, size, date of insertion, kind of pipe, etc., of service connections. These data are listed in a card index and filed by streets and numbers. The system likewise proposes under this head full plans of all pipes in important establishments which may have a special supply for sprinkler systems or other fire protection. These plans will indicate the relations between pipes carrying city water and private pipes which may carry a possible polluted water from a private source, introduced for the purpose of fire protection or manufacturing. The necessity for the complete severance of these dual supplies can be readily seen.

Assuming an available force of sufficient size and individual experience and capacity, the work of mapping pipes and valves proceeds normally along three lines:

(1) Compilation of existing data wherever and however those data may be listed.

(2) An investigation and determination of the present and possible function and use of the several parts of the system. [Conducted more or less incidentally in the course of the regular work by the pitometer corps and of the general repair and maintenance forces.—Editor.] Each foreman in charge of a repair or maintenance crew is furnished with a pad of paper showing the lines of typical street intersection with house lines, curb lines, etc., printed on it. Whenever and wherever such a crew is called for work, the foreman is required in his spare minutes, which always occur in such an operation, to list up on these blanks such data as an intelligent inspection of his immediate vicinity will discover.

(3) The proper recording of new work and the reduction to tangible shape of existing data.

Finally, the system in vogue in Philadelphia depends upon centralized overhead control. All new work is directed from a central office thereby insuring uniform practice and procedure, stimulating branch offices by the feeling that their returns are scrutinized and compared with similar returns from other branch offices. Uniform practice and procedure is essential as a man transferred from one section of the city to another feels at home among the familiar records, even though the geography of the district is strange.

Book records have been discarded as far as possible in favor of records capable of easy and rapid reproduction. A complete and satisfactory record, distributed as widely as desired, may not be obtained for some time to come but enough has already been accomplished to prove the worth of the system.

*Condensed from a paper read before the Engineering Section of the Association for the Advancement of Science, Philadelphia, December, 1914.

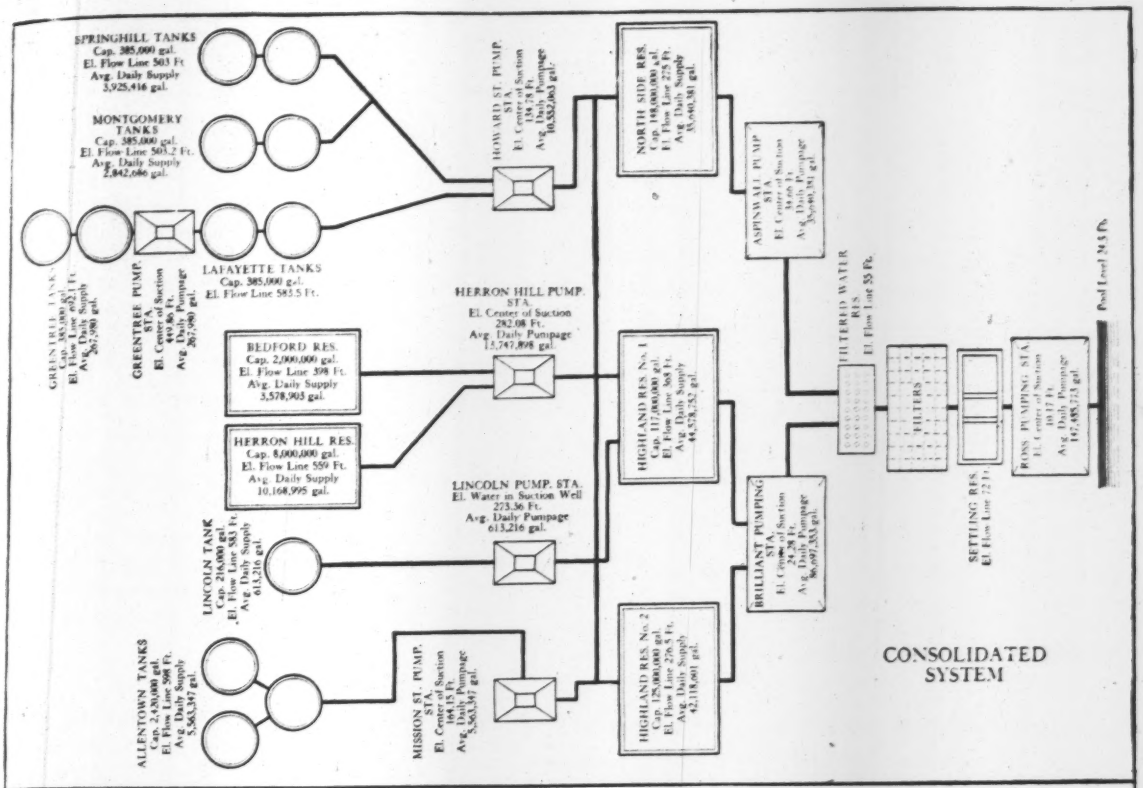
†Chief of the Bureau of Water, Philadelphia, Penn.

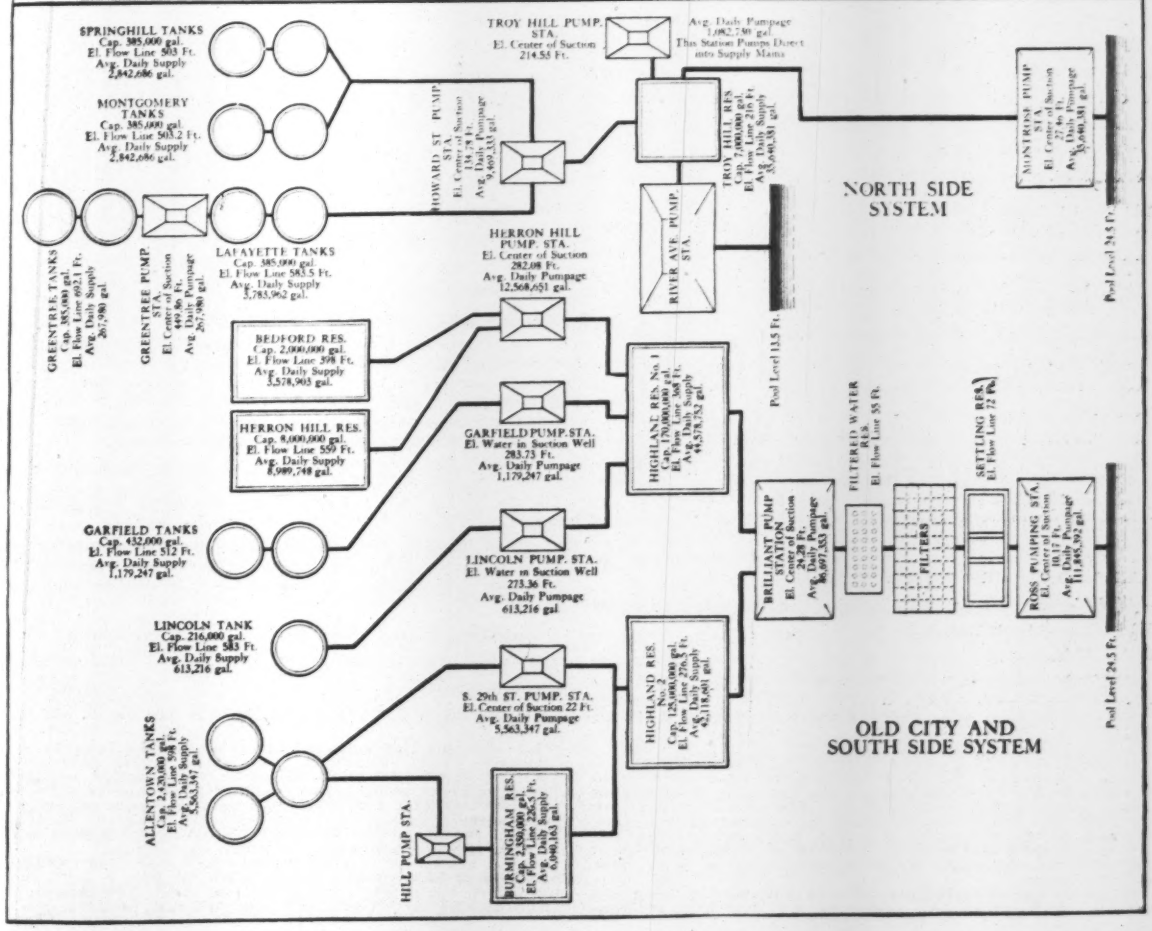
Interesting Chart of Pittsburgh Water System, Showing Its Recent Transformation

Extensive rearrangement of the water-supply system of the former cities of Pittsburgh and Allegheny—now joined in the enlarged Pittsburgh—has been in process during the last two or three years. Recently the new Cabbage Hill Reservoir on the North Side (Allegheny) was put into service, and at the same time a new pumping station at Aspinwall was started, pumping from the city's filter plant to the Cabbage Hill Reservoir. With this change the independent water systems of the two former cities became consolidated, and the North Side was supplied with filtered water. A final step in the junction of the two systems is now being carried out by the installation of a 48-in. subaqueous main across the river, connecting the primary or low-service district of the two sides of the river; these are served directly by the Cabbage Hill reservoir on the North Side and one of the two Highland reservoirs in Pittsburgh itself. A second cross-river connection between the primary systems will be installed shortly in the shape of a 30-in. main going by way of the new Point Bridge.

The diagram on the opposite page was drawn to show the various relations of the old water systems and the new or transformed systems. In addition the diagram gives a great amount of detail information, and as a whole represents a most valuable summary of the city's water-supply system. The diagram was drawn up under the direction of C. A. Finley, Superintendent, Bureau of Water, Pittsburgh.

An important item of the transformation is the reduction of the number of pumping stations. Four secondary pumping stations take the place of the former seven.


SPRINGHILL TANKS
Cap. 385,000 gal.
El. Flow Line 503 Ft.
Avg. Daily Supply
3,925,416 gal.
MONTGOMERY TANKS
Cap. 385,000 gal.
El. Flow Line 503.2 Ft.
Avg. Daily Supply
2,842,686 gal.
GREENTREE TANKS
Cap. 385,000 gal.
El. Flow Line 692.1 Ft.
Avg. Daily Supply
267,980 gal.
GREENTREE PUMP. STA.
El. Center of Suction
Ft.
Avg. Daily Pumpage
267,980 gal.
LAFAYETTE TANKS
Cap. 385,000 gal.
El. Flow Line 583.5 Ft.
HOWARD ST. PUMP. STA.
El. Center of Suction
134.75 Ft.
El. Center of Suction
134.75 Ft.
Avg. Daily Pumpage
10,552,063 gal.
NORTH SIDE RES.
Cap. 148,000,000 gal.
El. Flow Line 275 Ft.
Avg. Daily Supply
35,640,381 gal.
ASPINWALL PUMP STA.
El. Center of Suction
13.66 Ft.
Avg. Daily Pumpage
35,640,381 gal.
HERRON HILL PUMP. STA.
El. Center of Suction
282.08 Ft.
Avg. Daily Pumpage
15,747,898 gal.
BEDFORD RES.
Cap. 2,000,000 gal.
El. Flow Line 398 Ft.
Avg. Daily Supply
3,578,903 gal.
HERRON HILL RES.
Cap. 8,000,000 gal.
El. Flow Line 559 Ft.
Avg. Daily Supply
10,168,995 gal.
HIGHLAND RES. No. 1
Cap. 117,000,000 gal.
El. Flow Line 368 Ft.
Avg. Daily Supply
44,578,752 gal.
FILTERED WATER RES.
El. Flow Line 55 Ft.
FILTERS
SETTLING RES.
El. Flow Line 72 Ft.
ROSS PUMPING STA.
El. Center of Suction
10.17 Ft.
Avg. Daily Pumpage
147,455,773 gal.
Pool Level 34.5 Ft.
LINCOLN PUMP. STA.
El. Water in Suction Well
273.36 Ft.
Avg. Daily Pumpage
613,216 gal.
LINCOLN TANK
Cap. 216,000 gal.
El. Flow Line 583 Ft.
Avg. Daily Supply
613,216 gal.
BRILLIANT PUMPING STA.
El. Center of Suction
24.28 Ft.
Avg. Daily Pumpage
80,097,253 gal.
ALLENTOWN TANKS
Cap. 2,430,000 gal.
El. Flow Line 598 Ft.
Avg. Daily Supply
5,563,347 gal.
MISSION ST. PUMP. STA.
El. Center of Suction
Ft.
Avg. Daily Pumpage
5,563,347 gal.
HIGHLAND RES. No. 2
Cap. 125,000,000 gal.
El. Flow Line 276.5 Ft.
Avg. Daily Supply
42,118,601 gal.
CONSOLIDATED SYSTEM


SPRINGHILL TANKS
Cap. 385,000 gal.
El. Flow Line 503 Ft.
Avg. Daily Supply
2,842,686 gal.
MONTGOMERY TANKS
Cap. 385,000 gal.
El. Flow Line 503.2 Ft.
Avg. Daily Supply
2,842,686 gal.
GREENTREE TANKS
Cap. 385,000 gal.
El. Flow Line 692.1 Ft.
Avg. Daily Supply
267,980 gal.
GREENTREE PUMP. STA.
El. Center of Suction
Ft.
Avg. Daily Pumpage
267,980 gal.
LAFAYETTE TANKS
Cap. 385,000 gal.
El. Flow Line 583.5 Ft.
Avg. Daily Supply
5,783,962 gal.
TROY HILL PUMP. STA.
El. Center of Suction
214.55 Ft.
Avg. Daily Pumpage
1,082,740 gal.
This Station Pumps Direct into Supply Mains
HOWARD ST. PUMP. STA.
El. Center of Suction
134.75 Ft.
Avg. Daily Pumpage
9,469,323 gal.
TROY HILL RES.
Cap. 2,000,000 gal.
El. Flow Line 216 Ft.
Avg. Daily Supply
35,640,381 gal.
MONTROSE PUMP STA.
El. Center of Suction
22.7 Ft.
Avg. Daily Pumpage
35,640,381 gal.
NORTH SIDE SYSTEM
RIVER AVE. PUMP. STA.
HERRON HILL PUMP. STA.
El. Center of Suction
282.08 Ft.
Avg. Daily Pumpage
12,568,651 gal.
BEDFORD RES.
Cap. 2,000,000 gal.
El. Flow Line 398 Ft.
Avg. Daily Supply
3,578,903 gal.
HERRON HILL RES.
Cap. 8,000,000 gal.
El. Flow Line 559 Ft.
Avg. Daily Supply
8,989,748 gal.
HIGHLAND RES. No. 1
Cap. 170,000,000 gal.
El. Flow Line 368 Ft.
Avg. Daily Supply
44,578,752 gal.
Pool Level 13.5 Ft.
Pool Level 34.5 Ft.
GARFIELD PUMP. STA.
El. Water in Suction Well
283.73 Ft.
Avg. Daily Pumpage
1,179,247 gal.
GARFIELD TANKS
Cap. 432,000 gal.
El. Flow Line 512 Ft.
Avg. Daily Supply
1,179,247 gal.
LINCOLN PUMP. STA.
El. Water in Suction Well
273.36 Ft.
Avg. Daily Pumpage
613,216 gal
LINCOLN TANK
Cap. 216,000 gal.
El. Flow Line 583 Ft.
Avg. Daily Supply
613,216 gal.
BRILLIANT PUMP STATION
El. Center of Suction
24.28 Ft.
Avg. Daily Pumpage
80,097,253 gal.
FILTERED WATER RES.
El. Flow Line 55 Ft.
FILTERS
SETTLING RES.
El. Flow Line 72 Ft.
ROSS PUMPING STA.
El. Center of Suction
10.17 Ft.
Avg. Daily Pumpage
111,845,592 gal.
S. 29th ST. PUMP. STA.
El. Center of Suction 22 Ft.
Avg. Daily Pumpage
5,563,347 gal.
HIGHLAND RES. No. 2
Cap. 125,000,000 gal.
El. Flow Line 276.5 Ft.
Avg. Daily Supply
42,118,601 gal.
ALLENTOWN TANKS
Cap. 2,430,000 gal.
El. Flow Line 598 Ft.
Avg. Daily Supply
5,563,347 gal.
HILL PUMP STA.
BURMINGHAM RES.
Cap. 2,500,000 gal.
El. Flow Line 226.5 Ft.
Avg. Daily Supply
8,040,183 gal.
OLD CITY AND SOUTH SIDE SYSTEM

Wind Stresses in Railroad Bridges

By R. Fleming*

SYNOPSIS—The Tay Bridge failure reviewed. English practice in the 70's ignored wind stresses, while American engineers used methods nearly equal to those of today. Empirical development is the basis of practice. Modern specifications show a great number of variations in detail, but may be brought nearer uniformity in the future. Lateral-oscillation forces should be specified separate from wind pressure.

The purpose of this article is to review past and present practice of the treatment of the wind forces acting on railroad bridges.

The Tay Bridge

On the evening of Dec. 28, 1879, occurred the "Tay Bridge Disaster." During a violent gale, 11 spans of 245 ft. and two of 227 ft., with the train passing over them at the time, fell into the river. This failure of what was at the time the largest bridge in the world after a service of less than two years marked an epoch in bridge building in Great Britain. Wind stresses in railroad bridges had previously been almost neglected; from that time they have been fully considered, if not magnified. A Court of Inquiry was appointed by the English Board of Trade to report on the causes of the disaster. Today the testimony taken regarding the provision made in the design of the bridge for wind stresses is interesting reading.

Sir George Airy, Astronomer Royal, testified that about seven years previously he had been consulted on the subject of the provision which should be made for wind pressure on the plans prepared by Sir Thomas Bouch of a bridge of two spans of 1600 ft. over the Forth. He gave as his opinion that the greatest wind pressure that might be expected over the whole extent of such a surface was 10 lb. per sq.ft.

Sir Thomas Bouch, the designer of the Tay bridge, testified that he did not specially make any allowance for wind pressure, but he had seen the report on the Forth Bridge; he thought the greatest pressure would be about 10 lb.

The majority report of the Court of Inquiry ends:

> In conclusion, we have to state that there is no requirement issued by the Board of Trade respecting wind pressure, and there does not appear to be any understood rule in the engineering profession regarding wind pressure in railway structures; and we therefore recommend that the Board of Trade should take such steps as may be necessary for the establishment of rules for that purpose.

A minority report was submitted by the third member of the Court.† An extract is:

> It is said that Sir Thomas Bouch must be judged by the state of our knowledge of wind pressure when he designed and built the bridge. Be it so; yet he knew or might have known that at that time the engineers in France made an allowance of 55 lb. per sq.ft. for wind pressure, and in the United States an allowance of 50 lb.

In the engineering literature of 1880 and [illegible] paper often referred to is "The Tay Bridge," by Edgar Gilkes, a member of the firm building the bridge. It was read before the Cleveland Institution of Engineers, Nov. 6, 1876. The special paragraph that must have plagued the author reads:

> A consideration of the action of the wind on this bridge will dissipate the often-advanced theory that at some period it will be blown over. The exposed surface of one large pier is about 800 sq.ft., and of the superstructure which depends upon it, about 800 more, and so, giving 800 ft. for a train above, we have 2400 ft. Twenty-one pounds per sq.ft. is the force of a very strong gale, but it would take no less than 96 lb. per sq.ft. on the surface given to overturn the pier. Even the most severe hurricane on record would equal only one-half this resultant power.

C. Shaler Smith, after a careful calculation in accordance with American rules, found the exposed surface of the superstructure to be 2576 sq.ft. instead of 800, while the London *Engineering* shows the exposed train surface was 1630 sq.ft. instead of 800.

Early English Practice

It is surprising how little is found in the English technical books and papers of those days regarding the force of the wind on structures. Humber, in his voluminous "Complete Treatise on Cast- and Wrought-Iron Bridge Construction," published in 1861, does not mention it. Unwin's "Wrought-Iron Bridges and Roofs," 1869, was a far better textbook than any that had preceded it. What he writes regarding wind pressure on roofs is still quoted; yet he says nothing of wind stresses in bridges. The article on Bridges, by Prof. Jenkin, in the ninth edition of the "Encyclopedia Britannica" (1876), afterward issued as a separate treatise, fills 58 closely written pages, but not a line is found concerning wind bracing.

Thomas Cargill, in his "The Strains upon Bridge Girders and Roof Trusses," 1873, writes:

> No allowance is made in the theoretical calculation for the violent shock, concussion and consequent vibration that attend the passage of a heavy train over a bridge. This must be allowed for by experience, by the introduction of such additional bracing as the skill of the engineer suggests. These are points which cannot be learned from books.

To the effect of the wind on a bridge he makes no allusion, though in the chapter "Curved Roof Trusses," he says:

> Some writers lay great stress upon providing a large margin of strength for wind pressure, but there is more theoretical than practical knowledge displayed in such statements.

Rankine, in his "Manual of Civil Engineering," in the early 60's, gives a formula for the effect of wind on tubular girders, and in a footnote states that the greatest pressure of wind ever observed in Britain was 55 lb. per sq.ft.,

*American Bridge Co., 30 Church St., New York City.

†The majority of the Court of Inquiry reported that in their opinion the cross bracing at the pier and its fastening by lugs was the first part to yield. The evidence, however, was ample to justify the language of the minority report, "that this bridge was badly designed, badly constructed, and badly maintained, and that its downfall was due to inherent defects in the structure which must sooner or later have brought it down."

The piers which failed carried two adjoining trusses and consisted of a hexagonal group of six cast-iron columns filled with portland cement, two 18 in. and four 15 in. in diameter. Each column in case of the higher columns was made of seven lengths 10 ft. 10 in. long, united by flanges. These columns were braced vertically on the exterior sides by struts of two 6-in. channels and diagonals of 4½x½-in. flats fastened to cast-iron lugs with 1⅛-in. bolts. Horizontal bracing connected the four interior columns. It will readily be seen that such a system is weak throughout.

As a matter of interest it may be noted that during the progress of construction on the night of Feb. 2, 1877, two of the 245-ft. spans were blown into the river. To this accident "Engineering" of Feb. 9, 1877, devoted just 14 lines.

but we have no record that this observation ever entered into the consideration of bridge engineers.

The first German edition of Ritter's "Elementary Theory and Calculation of Iron Bridges and Roofs," was issued in 1862. An English translation was published in 1879. In this book the lateral force is taken as a percentage of the combined vertical live- and dead-loads. In one particular bridge under consideration, it is assumed to be one-seventh.

The outcome of the agitation following the fall of the Tay Bridge was a commission appointed by the Board of Trade to consider the question of wind pressure on railway structures. This committee made its report in 1881. The substance of its five recommendations was: (1) That for railway bridges and viaducts a maximum wind pressure of 56 lb. per sq.ft. should be assumed for the purpose of calculation. (2) That the area of exposed surface should be taken at once to twice the front surface, according to the extent of the openings in the trusses or lattice-girders. (3) That a factor of safety of 4 should be used for strains caused by wind pressure, and for the whole structure overturning as a mass a factor of safety of 2 should be used. These recommendations became law in Great Britain.

Early American Practice

Not less interesting is the historical development of wind bracing in the United States. In 1851 was published, "General Theory of Bridge Construction," by Herman Haupt, A.M., General Superintendent of the Pennsylvania R.R., formerly professor of Mathematics in Pennsylvania College. The pioneer book in which bridge trusses are correctly analyzed is "A Work on Bridge Building," by Squire Whipple, published at Utica, N. Y., in 1847. Whipple's book was little known for a long time after its publication, while Haupt's book, written without any knowledge of the existence of Whipple's, soon became widely circulated and for years was regarded as an authority. In Part 1 of Haupt's book we read:

> The use of lateral bracing is principally to guard against the effects of wind, and other disturbing causes, tending to produce lateral flexure in the roadway * * * The greatest lateral strain is that produced by the action of a high wind; assuming the force of wind at 15 lb. per sq.ft., as a maximum, * * *

In Part II, written some time after Part I, we read, "The heaviest locomotives in use weigh about 23 tons, and their length is 23 ft.," and further on:

> The greatest strain upon the lateral bracing of a bridge would be that caused by the action of the wind in a violent tornado. It is probable that this force is far greater than it is usually estimated. The observations of the writer at the Susquehanna Bridge, during the tornado which caused the loss of six of the unfinished spans, led him to believe that the direct effect of the storm was increased by reflection from the surface of the water. * * * If we suppose a storm could be so violent as to cause a pressure of 30 lb. per sq.ft., * * *

The tornado alluded to occurred Mar. 27, 1849. A viaduct across the Susquehanna River, near Harrisburg, was being built for the Pennsylvania R.R. It was supported on 22 piers, 160 ft. center to center. The trusses were of the Howe type, with the addition of wooden arches. After the fourteenth span had been raised, the storm came and carried off six spans. The contractor was busy at the time putting in the arches, and as the diagonal braces could not be fastened until after the arches were in place, they had been omitted except over the piers and in the middle of the spans. The wind came at right angles to the bridge and the six spans without lateral bracing gave way.

As late as the early 70's American textbooks had little or nothing to say on wind bracing. De Volson Wood devotes less than one-half a page to the subject in his "Theory on the Construction of Bridges," while Greene in "Bridge Trusses" spares only a page. Col. Merrill, in his "Iron-Truss Bridges for Railroads," makes no mention of wind bracing. Shreve, whose "Treatise on the Strength of Bridges and Roofs" was translated into French, finds vertical strains, horizontal strains, chord strains, brace strains, but the word wind does not occur in the book, nor is any mention made of bracing in a horizontal plane. Nearly the same might be written of Roebling's "Long and Short Span Railway Bridges," 1869.

American practice, however, was ahead of the teaching profession. C. Shaler Smith, on Dec. 15, 1880, presented a masterly paper to the American Society of Civil Engineers, entitled, "Wind Pressure upon Bridges." He gives specifications which he had used in constructing a number of bridges, some of them high and in exposed localities. He specifies:

> The portal, vertical and horizontal bracing shall be proportioned for a wind pressure of 30 lb. per sq.ft. on the surface of a train averaging 10 sq.ft. per lin.ft., and on twice the vertical surface of one truss. The 300 lb. pressure per lin.ft. due to the train surface shall be treated as a moving load, and the pressure on the trusses as a fixed load. Trusses of less than 200 ft. span shall also be proportioned for a pressure of 50 lb. per sq.ft. where unloaded, and the greatest strain by either method of computation shall in each case be used in determining the sectional area of the bracing.

Several leading railway companies at that time were using practically these specifications. From this same paper the following is significant:

> Many engineers prefer to express wind force in pounds per lineal foot of bridge instead of per square foot of exposed surface. Using a 200-ft. span as an example, the specifications in question can be condensed as follows:
>
> Fixed load in plane of roadway, 210 lb. per lin.ft.
> Fixed load in plane of other chord, 130 lb. per lin.ft.
> Moving load in plane of roadway, 300 lb. per lin.ft.

It is refreshing to see C. Shaler Smith quoted as the exponent of American practice for wind bracing in the article on Bridges, by Unwin, in the eleventh edition of the "Encyclopedia Britannica."

The rules in the Erie Specifications, formulated in 1878 by Theodore Cooper, were:

> To provide for wind strains and vibrations, the top lateral bracing in deck bridges and the bottom lateral bracing in through bridges shall be proportioned to resist a lateral force of 450 lb. for each foot of the span, 300 lb. of this to be treated as a moving load.
>
> The bottom lateral bracing in deck bridges and the top lateral bracing in through bridges shall be proportioned to resist a lateral force of 150 lb. for each foot of the span.

It is thus seen that in the early days of iron railway bridges, the American engineers were far in advance of their English brethren in the recognition of wind forces.

Factors in the Problem

"A Practical Treatise on Bridge Construction," by T. Claxton Fidler, was published in London in 1887. Chapter XXIV is "On Wind-Pressure and Wind-Bracing." In 1894, Captain (now General) Bixby, U. S. A., in a monograph reviewing the literature on wind pressure, writes: "The chapter is perhaps the best single, short, concise, comprehensive and practical review of the whole subject yet in print." This characterization in a large

measure still holds true. Some concluding sentences from the chapter are:

> We have seen, for example, how large a proportion of the metal in a long-span bridge is required for the purpose of resisting wind-pressure and for the purpose of carrying the metal that resists wind-pressure. But we have also seen that it is really impossible to estimate the wind stresses within 100% of their real value. * * * In this state of uncertainty, the responsible engineer will generally be disposed to err on the safe side; but it must be remarked that this will be a very expensive proceeding. * * * On the other hand, he knows that an error in the opposite direction might be attended with still more disastrous results.

The sting of these sentences is in their truth. Our knowledge of the wind is uncertain, especially regarding the higher velocities. Although there are many unknown quantities in the problem of wind stresses in a bridge, the main questions to be considered are two:

(1) What is the pressure to be assumed per unit of area?

(2) What shall be taken as the area exposed to the action of the wind?

Wind pressure is generally measured in terms of the velocity. According to the best information we have, an indicated velocity by the (Weather-Bureau standard) anemometer of 100 miles per hour denotes an actual velocity of 76 miles, which is equivalent to a pressure of 23 lb. per sq.ft. on a surface at right angles to its direction. A pressure of 30 lb. per sq.ft., which corresponds to an indicated velocity of about 120 miles per hour, will overturn empty freight cars, the ordinary passenger car, and acting over an extended area of land would sweep from it all trees. No engine driver could take his train upon a bridge with such a pressure, though it is possible that the train during a sudden gust might be caught there. A man could not keep his feet with such a pressure, no matter at what angle his legs were inclined to the ground. It would seem that 30 lb. per sq.ft. is ample for assumed wind pressure.

The second question to be considered is even more difficult to answer than the first. In a bridge composed of two or more trusses several feet apart, and each truss made up of members which may shelter other members, the case is far different from that of wind on a plate or on a solid body. Our actual knowledge of the subject is slight. Baker's experiments at the Forth Bridge* and Stanton's experiments at the National Physical Laboratory† are generally quoted. Bridge engineers and writers on the subject vary in their methods. C. Shaler Smith, as previously noted, uses an exposed area of "twice the vertical surface of one truss." In estimating the vertical surface of *one* truss he adds to the elevation of the upper chord and posts, as seen on the drawing, 1½ times the surface of the ties, and twice the surface of the lower chord.‡ Du Bois, in his "The Stresses in Framed Structures," gives as a rule this method for finding the area of surface of a single truss. "In preliminary estimates," he writes, "we may take the exposed surface for *both trusses* at 10 sq.ft. per lin.ft."

Johnson, Bryan and Turneaure, in "The Theory and Practice of Modern Framed Structures," use "the exposed surface of all trusses and the floor as seen in elevation." Merriman and Jacoby, in "A Text Book on Roofs and Bridges," Heller in "Stresses in Structures," and a number of other writers do the same. "Str[illegible]al Engineering," an English textbook by Husbat[illegible] and Harby, says "The area of the bridge exposed to the [illegible]er pressure will be from once to about three times the [illegible] as seen in elevation, depending on the type of con[illegible]tion." Another English textbook, Anglin, "The [illegible] of Structures," says, "In double-webbed lattice girder[illegible] the area of both webs should be taken, or double the we[illegible] as seen in elevation, ... If a bridge consists of two such main girders, the wind pressure must be taken as acting on an area equal to *four times* that as seen in elevation." This same textbook adds, "American engineers assume a wind pressure of 30 lb. per sq.ft. upon the loaded, and 50 lb. upon the unloaded structure."

From the foregoing it is readily seen that specifications that simply give the load per square foot of exposed surface to be used do not fully specify. Descriptions of bridges which state the lateral pressure per square foot used in the calculations without defining the extent of exposed surface intended by the designer are incomplete in their description.

It is to be remembered that there are stresses due to lateral forces other than the wind. A considerable lateral force is developed by a rapidly moving train, or the lurching of a locomotive when it first strikes a bridge. This lateral vibration appears to be much more accidental in its character than the vertical vibration.* Even were there no wind, rigidity would have to be maintained against this lateral vibration, which in short spans is probably a greater factor than the wind pressure itself. We have nothing to determine a relation between lateral vibration and wind strain.

Further, the compression chords of bridges must be held in alignment by the lateral bracing. The amount of material required to do this is not, with our present knowledge, a matter of exact calculation.†

In some specifications provision for all lateral forces, except the centrifugal force when the track is on a curve, is included in that for wind pressure without being so stated. In others, "for lateral forces" or "for wind loads and lateral vibration" are the words used and more clearly express what is intended.

Giving the lateral force in terms of pounds per lineal foot of bridge (rather than in pounds per square foot) has a decided advantage in the preparation of designs for competition, as all bidders are working upon the same basis. Theoretically, for the wind itself the pressure per square foot is to be preferred and the force that produces lateral vibration is best represented by a percentage of the moving load. As engine weights and car loads are increased, provision is thus made for the increased tendency to vibration. Again, a different lateral force for spans under 200 ft. from that for spans over 200 ft. is assumed by some engineers.

While the wind pressure on a moving train should be treated as a moving load, engineers are divided in their opinions as to the wind load on the structure itself; some considering it uniform and some moving.

In regard to end anchorage, the following will be quoted from Waddell's "De Pontibus": "No matter how great its weight may be, every ordinary fixed span should be anchored effectively to its support at each bearing on

*"Engineering," Sept. 5, 1884.

†"Proc. of Inst. of C. E.," Vol. CLVI and Vol. CLXXI.

‡"Trans. Am. Soc. C. E.," Vol X, pp. 170. (Private letter to O. Chanute.)

*Robinson, "Vibration of Bridges." Trans. Amer. Soc. C. E., Vol. XVI, p. 42.

†Reichman, "Journal of the Western Soc. of Eng's," Vol. 29, p. 93.

same." (Principle XXVI, in chapter "First Principles of Designing.")

In passing, a criticism will be launched at the English bridges of "an early Victorian type,"* having an arched portal strut at every post and no top laterals. Some of these are of late date. All are wasteful in material, and there is great ambiguity in regard to the lateral stresses.

Present Specifications

The specifications of the American Railway Engineering Association, 1910, read:

All spans shall be designed for a lateral force on the loaded chord of 200 lb. per lin.ft. plus 10% of the specified train load on one track, and 200 lb. per lin.ft. on the unloaded chord; these forces being considered as moving.

The American Bridge Co. or Schneider specifications assume the wind pressure:

First, at 30 lb. per sq.ft. on the exposed surface of all trusses and the floor as seen in elevation, in addition to a train of 10 ft. average height, beginning 2 ft. 6 in. above base of rail, moving across the bridge. Second, at 50 lb. per sq. ft. on the exposed surface of all trusses and the floor system. The greatest result shall be used in proportioning the parts.

The Cooper specifications call for provision to be made to resist a lateral force of 600 lb. per lin.ft. on the loaded chord, of which 450 lb. is to be treated as a moving load acting on a train of cars at a line 6 ft. above base of rail. The unloaded chord is to resist a lateral force of 200 lb. per lin.ft. for spans up to 200 ft., and 25 lb. for each additional 50 ft.

The specifications of the railroads mentioned below are selected from a larger number to show the varying assumptions made of the amount of wind and lateral forces to be used in the design of railroad bridges. The wind is assumed to act horizontally at right angles to the bridge. Pounds per lineal foot means lineal foot of bridge.

Baltimore & Ohio R.R. Co.—A moving lateral force of 600 lb. per lin.ft. against the loaded chord, and 200 lb. per lin.ft. against unloaded chord.

Buffalo, Rochester & Pittsburgh Ry. Co.—(a) On the loaded structure, 30 lb. per sq.ft. on the exposed surface of all trusses and the floor system as seen in elevation, and on a moving train surface of 10 ft. average height beginning 2 ft. 6 in. above base of rail. (b) On the unloaded structure, 50 lb. per sq.ft. (instead of 30). In no case shall a lateral force of less than 200 lb. fixed and 300 lb. moving per lin.ft. be used for the loaded chord and less than 150 lb. per lin.ft. fixed for the unloaded chord.

Canadian Pacific Ry. Co.—Same as the Schneider specifications.

Chesapeake & Ohio Ry. Co.—Against the unloaded chord a fixed force of 200 lb. per lin.ft. for all spans of 200 ft. and under, and an additional force of 10 lb. per lin.ft. for every 25 ft. increase in span over 200 ft. Against the loaded chord same as above with an additional force of 500 lb. per lin.ft. acting 8 ft. above base of rail and treated as a moving load.

Chicago, Milwaukee & St. Paul Ry. Co.—A lateral force of 750 lb. per lin.ft. against the loaded chord, and 200 lb. per lin.ft. against the unloaded chord, these forces being considered as moving.

Delaware & Hudson Co.—For the loaded chord 300 lb. per lin.ft. moving load and 200 lb. per lin.ft. dead-load. For the unloaded chord, 200 lb. per lin.ft. dead-load. For double-track bridges these loads shall be increased one-half.

Delaware, Lackawanna & Western R.R.—A moving load of 300 lb. per lin.ft. against the loaded chord, and a uniform load of 300 lb. per lin.ft. divided equally between loaded and unloaded chords.

Grand Trunk Railway System has "Private" printed on the title page of its specifications and hence they can not be quoted.

Harriman Lines—Same wording as Buffalo, Rochester & Pittsburgh Ry. Co. above.

Lehigh Valley R.R. Co.—A moving load of 700 lb. per lin.ft. against the loaded chord and a moving load of 300 lb. per lin.ft. against the unloaded chord.

Long Island R.R. Co.—(1st) A load of 30 lb. per sq.ft. "on the exposed surface of entire surface as seen in elevation" (but never less than 200 lb. per lin.ft. at the unloaded chord), and on a moving train 10 ft. high beginning 2 ft. 5 in. above base of rail; (2d) 50 lb. per sq.ft. on "the exposed surface of the entire structure as seen in elevation."

Mexican International R.R. Co.—Six hundred pounds per lineal foot against the loaded chord and 200 lb. per lin.ft. against the unloaded chord, both forces considered as moving.

*The Tugela Bridge, "Engineering," Jan. 26, 1900.

National Lines of Mexico—On the unloaded structure 50 lb. per sq.ft. "on the geometrical elevation of the completed structure and track." On the loaded structure, "30 lb. per sq.ft. of said elevation," plus the moving surface of train 10 ft. high, beginning 2½ ft. above the base of rail. In no case shall the fixed wind pressure be less than 150 lb. per lin.ft. for each chord of any bridge.

New York Central Lines—(1st) A moving load of 30 lb. per sq.ft. on 1½ times the vertical projection of the structure on a plane parallel with its axis (but never less than 200 lb. per lin.ft. at the unloaded chord), and a moving load of 360 lb. per lin.ft. applied 8 ft. above the base of the rail. (2d) A moving load of 50 ft. per sq.ft. on 1½ times the vertical projection of the unloaded structure on a plane parallel with its axis.

New York, New Haven & Hartford R.R. Co.—Same as the A. R. E. Assn.

New York, Ontario & Western Ry. Co.—Same as the A. R. E. Assn. For double-track bridges the constants are increased 50% but the percentage of live-load remains the same.

Norfolk & Western Ry. Co.—Same as the Schneider specifications, but omitting "beginning 2 ft. 6 in. above base of rail."

Pennsylvania R.R. Co.—Same as the Schneider specifications.

Pennsylvania Lines West of Pittsburgh—A uniform load of 150 lb. per lin.ft. against the unloaded chord and 200 lb. per lin.ft. against the loaded chord. A moving load of 300 lb. per lin.ft. against the loaded chord acting at a line 6 ft. above the base of rail.

Philadelphia & Reading Ry. Co.—A uniform load of 200 lb. per lin.ft. against each chord and a moving load of 400 lb. per lin.ft. against the loaded chord with its point of application 7½ ft. above the rail.

Piedmont & Northern Lines—Same as A. R. E. Assn.

Seaboard Air Line Ry.—Same as A. R. E. Assn.

Southern Ry. Co.—Same as A. R. E. Assn.

Western Maryland Ry. Co.—Dead-load, 150 lb. per lin.ft. against the unloaded chord, and 200 lb. per lin.ft. against the loaded chord. Moving load, 400 lb. per lin.ft. against the loaded chord, applied at a distance of 6 ft. above the base of rail.

Western Pacific Ry. Co.—Same as Western Maryland.

The wide range of requirements demanded in existing specifications shows the difficulty of uniting on a common standard. At present an increasing number of railroad engineers is following the specifications of the American Railway Engineering Association. In Europe, bridges are built in accordance with rules and regulations prepared by the respective governments. This at times is an advantage, at other times it is not. Unwin writes: 'English bridge builders are somewhat hampered in adopting rational limits of working stresses by the rules of the Board of Trade."

Working Stresses

The required material in a bridge depends upon assumed unit stresses as well as upon assumed loadings. Some ten years ago, the late Professor Heller* found that for the same live- and dead-load stresses in a bottom-chord member of a 134-ft. span, there was a variation from 11.4% below to 18.6% above the average section of 25.4 sq.in. required by the 28 specifications he examined. In the specifications of the 25 railroads mentioned above, with the total stresses assumed by Heller, the variation is from 11.65% below to 9.33% above the average of 24.97 sq.in. required. There is nearly a unanimity in using for the combined stress due to lateral forces, plus live- and dead-loads, a unit-stress 25 or 30% greater than that due to the live- and dead-loads alone.

In this connection attention is called to the bending stresses in the end posts due to portal bracing; and the stresses induced in different members when the bridge is figured for overturning moments. These are not to be neglected, nor are centrifugal stresses when track is on curve.

Long Spans

What has been written and the specifications quoted apply primarily to railroad bridges of noncontinuous truss spans. When the Ohio River bridge between Cincinnati and Covington was finished in 1889 with a center span of 545 ft. and two spans of 486 ft., it had the distinction

*"Engineering News," Nov. 19, 1903.

of having the longest and heaviest simple truss that had been built either in the United States or in Europe. The specifications called for a wind pressure of 30 lb. per sq.ft. on the exposed surface of both trusses and the vertical projection of the floor system, and on a moving-train surface averaging 10 sq.ft. per lin.ft.

The St. Louis Municipal Bridge has three spans, each of 668 ft. center to center of end pins, at present the longest simple truss spans in the world.* The permissible lengths of the spans are explained by 58% of the metal being nickel-steel. The wind loads assumed were 300 lb. per lin.ft. for the upper lateral system, and 600 lb. per lin.ft., one-half moving and one-half fixed, for the lower lateral system.

The Hell Gate Bridge, now building, will have the longest arch in the world—a span of 977½ ft. The paragraph in the specifications relating to wind pressure reads:

Wind pressure shall be assumed as a moving load of 500 lb. per lin.ft. in the plane of the tracks, plus 30 lb. per sq.ft. on such vertical surface of the unloaded bridge as shall be exposed at any angle between 20° above or 20° below the horizontal or at an angle of 45° from the axis of the bridge, but not less than 200 lb. per lin.ft. on any chord.

For 25 years the Forth Bridge of cantilever design, in Scotland, has remained the greatest bridge in the world. Its spans of 1700 ft. exceed in length and magnitude any other now standing. The wind loads and unit stresses used in the design were those of the English Board of Trade Regulations, which most engineers regard as excessive and needlessly severe. The table below, made by Sir Benjamin Baker from his calculations of stresses due to the separate loadings, will show the important part wind forces played in the design.

	Dead Load Stresses	Live Load Stresses	Wind Stresses	Total Stresses
Bottom member	2282	1022	2920	6224
Top member	2253	997	544	3794
Vertical member	1550	705	1024	3279
Diagonal struts	802	167	414	1383
Diagonal ties	754	186	194	1134
Horizontal wind bracing	80	5	265	350
Vertical wind bracing	42	169	108	319
Central girder—top	337	303	182	822
Central girder—bottom	330	301	247	878

Stresses are given in tons of 2240 lbs.

The Quebec Bridge, also of cantilever design, now building, will, when finished, eclipse the Forth Bridge, its enormous channel span being 1800 ft. long. The assumed wind loads are:

A wind load normal to the bridge of 30 lb. per sq.ft. of the exposed surface of two trusses and 1½ times the elevation of the floor (fixed load), and also 30 lb. per sq.ft. on travelers and falsework, etc. during erection.

A wind load on the exposed surface of the train of 300 lb. per lin.ft. applied 9 ft. above base of rail (moving load).

A wind load parallel with the bridge of 30 lb. per sq.ft. acting on one-half the area assumed for normal wind pressure.

Conclusion

The writer has no intention of passing judgment upon the specifications of engineers who have carried American bridge building to such a marked success. Standard specifications, as far as wind stresses are concerned, may not be practicable, but it should be possible to come nearer to points of agreement than at present. As an instance, the Lehigh Valley, the Philadelphia & Reading, and the Lackawanna railroads, all in the same territory, must have practically the same lateral forces; but the assumed forces vary nearly 75%. A discussion of the reasons for these variations would be interesting.

In no specifications that the writer has ever read is there an attempt to separate the stresses due to wind from those due to other lateral forces. The 10% of the weight of the train often specified for the lateral force on the loaded chord includes the wind pressure on the train. The wind pressure of 30 lb. per sq.ft. on a moving train, sometimes called for, includes the lateral force due to vibration. When the assumed loading is given in lb. per lin.ft., the total pressure due to all lateral forces is intended.

Perhaps in the future some engineer may be able to assign definite amounts to the different items that make up the total lateral force on a bridge. This would be one of the first steps to be taken to secure any degree of uniformity in proposed requirements for lateral stresses. As a beginning in this direction, the writer suggests that the lateral force on the loaded chord due to oscillation of the train be taken at 4% of the train load.

*Merriman and Jacoby in the last edition of their "Roofs and Bridges" enumerate 31 railway bridges and 6 combined railway and highway bridges which have simple truss spans of 400 ft. and over in length. Of these 15 are over 500 ft. and two, including the St. Louis bridge, are over 600 ft. The new Ohio River Bridge at Metropolis, recently contracted for, has a noncontinuous channel span of 700 ft. clear distance between piers.

A Refuse Incinerator with Steam Utilization, at Savannah, Ga.*

One of the few refuse incinerators in the United States, all the steam from which is utilized, was put in operation by the city of Savannah, Ga., on Mar. 24, 1914. This incinerator has a nominal daily capacity of 130 tons. The

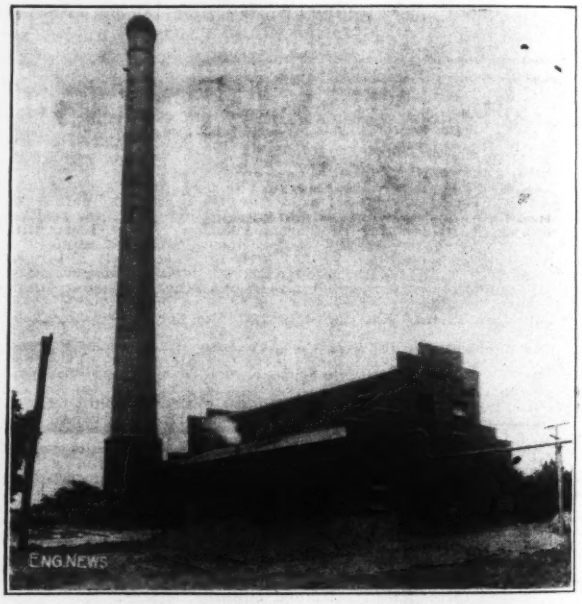


Fig. 1. General View of Refuse Incinerator, Savannah, Ga.

heat of combustion raises steam which, aside from that needed for works purposes, is piped a short distance to the water-works pumping station.

The population of Savannah is about 80,000. Of this some 60% is white and 40% colored. From Mar. 23 to

*Condensed and rearranged from a paper by E. R. Conant, Chief Engineer, Savannah, Ga., read before the American Society of Municipal Improvements, Boston, Mass., October, 1914.

FIG. 3. DRAWING CLINKER FROM REFUSE INCINERATOR, SAVANNAH, GA., ONTO CLINKER CAR

Oct. 1, a total of 18,033 tons of refuse was collected, including household, hotel and restaurant garbage and rubbish, paper and rubbish from stores, material from street receptacles, and some household ashes. The mean daily collection varied from 54 tons in March to about 100 tons in July. The average cost of collection was $2.29, including labor, care of stock, repairs to carts and harnesses and the purchase of small appliances for use in the collection work. At the height of the watermelon and cantaloupe season, the percentage of garbage, by weight, was about 55%. During the remainder of the year, the percentage of garbage varies from 40 to 45%. In winter the ashes collected do not amount to more than 10% of the total collection, if that.

FIG. 2. REFUSE HOPPER AND GRAB BUCKET FOR LIFTING AND CONVEYING REFUSE TO FURNACES, SAVANNAH, GA.

A low-temperature garbage furnace was built for Savannah in 1892. It proved to be unsatisfactory and was operated for only a few years. From 1902 until March, 1914, the Savannah refuse was dumped on waste land about four miles outside the city.

Early in 1913, E. R. Conant, Chief Engineer of Savannah, recommended to the city council that a high-temperature furnace or destructor be installed. This the council decided to do. General specifications were prepared and bids secured. In July, 1913, the council awarded to the Destructor Co. of New York City, a contract for a 130-ton incinerator of the Heenan (British) type. The final cost of the plant was $126,271. The plant was accepted by the city and final payment was made in October, 1914.

GENERAL DESCRIPTION OF DESTRUCTOR

The destructor was located near the city water-works pumping station—60 ft. between building walls, with 140 ft. from the destructor boilers to the main steam header in the pumping station.

The main features of the plant are: A 260-yd. refuse-storage pit, 11x32 ft. in plan and 20 ft. deep, into which the refuse is dumped from the collecting wagons; an electric traveling crane and hoisting grab bucket, for lifting the refuse from the pit and carrying it to and dumping it into the refuse containers, located over the destructor cells; two 65-ton destructor units, each having four trough-grate cells about 28 in. wide on the bottom, 34

in. wide on top, 16 in. deep and 8 ft. long; two 200-hp. Wickes water-tube boilers; a Foster preheater; a cylindrical centrifugal fan for supplying forced draft; a radial-brick stack 150 ft. high and 6⅔ ft. in diameter at the top; hydraulically operated clinkering devices, which discharge into clinker carts of special design; a steam turbo-generator for supplying electric current for works light and power purposes; various recording instruments; a wagon scale for weighing the incoming refuse; and a building to house the whole. Fig. 1 is an exterior view of the plant. Fig. 2 shows the refuse hopper and grab bucket. Fig. 3 shows the clinkering operation.

The cells have a burning area of 20 sq.ft. over each grate. The refuse containers over the cells have a capacity of about 1 cu.yd. each and are closed by horizontally sliding doors, in two parts, hydraulically operated. Stoking is done through a supplementary door, which makes it unnecessary to open the large clinkering door.

The clinker is pulled out by means of a hydraulic winch (Fig. 3), attached to a plate which forms "an upturned hoe placed on the bottom of the grate before the first charge of refuse is deposited in the cell." The sides of the grate diverge slightly from the rear to the stoking door. A clinkering operation is performed in three to four minutes. Usually the clinker is drawn once for each six charges of refuse. The average time of burning a charge is 20 min.

During July and August, about 10% of cinders from manufacturing plants was added to offset the excessive moisture in the refuse due to the melon season.

With the destruction of 60 to 75 tons of refuse per day, which comprised the collection in 1914, only one unit was operated, so as to supply steam to the pumping station continuously. The plant is operated in three shifts.

Contract Guarantees

The contract called for burning 130 tons of refuse in 24 hr., without additional fuel, and without the escape of odors or obnoxious gases from the building or chimney. It was stipulated that the temperature should not fall below 1250° F. at any time during normal operation and that an average of 1500° F. should be maintained in the combustion chamber. Not less than 68 lb. of refuse were to be burned per hr. per sq.ft. of grate surface on which combustion takes place, and not less than 1.3 lb. of steam from and at 212° F. was to be generated per lb. of refuse consumed. The cost of incineration was to be not more than 40.4c. per ton, based upon a stipulated schedule of men and wages. The net effective boiler capacity above that needed for works purposes was guaranteed to be 330 hp., based on 34.5 lb. of steam per boiler-horsepower.

The contract was based on refuse composed of 45% of garbage, 40% of rubbish, 10% of ash or cinder and 5% of manure by weight. Likewise the labor per shift was assumed to be one man to feed the hopper, four stokers, one engineer, one cranesman and one other man, making a total of $17.50 per shift, or $52.50 per 24 hr.

Contract Tests

On June 4, on June 25 and on Aug. 21 and 22, tests were made. All the guarantees were exceeded. Some of the leading data of these tests were:

	June 4	June 25	Aug. 21-2	Guaranteed
Duration, hr. and min.....	7 35	23 15	21 30	
Total refuse burned per sq.ft. of grate surface, lb.	72.25	69.94	80.6	68
Av. temperature of combustion chamber, ° F..	2100	1862	1845	1500
Total evaporation per lb. of refuse, lb.	1.53	1.49	1.62	1.3
Excess horsepower*	452	364	489	330

*Estimated horsepower used to operate plant, 11

The actual cost of operation was less than that guaranteed (given above), owing to the fact that the hoist operator was paid $2.25, and the four stokers $1.75 a day, instead of those five men receiving $2.40 each. This made the cost per shift $14.75 instead of $17.50, and the cost for three shifts $44.25 instead of $52.50. Accordingly, the Aug. 21-22 tests, on a 130-ton amount and 24-hr. time basis, gave a cost of 34c. per ton, instead of the guaranteed cost of 40.4c. Correcting this for 138.75 tons burned in 21½ hr. (in place of 130 tons in 24 hr., the contract guarantee) gives 31.8c. per ton as the labor cost of burning Savannah refuse during the final test.

Operating Costs under Working Conditions, Mar. 24 to Sept. 30, 1914

During a period of just over six months, 14,364 tons of refuse were burned at a total cost of $8988, including $428 for a weighman and $370 for a laborer at the pit, supervising the dumping of cars. This gives an average cost of 62½c., but in comparing this with the guaranteed cost of 40.4c., it must be remembered that the guaranteed price was based on the plant working at full capacity. Deducting the value of fuel saved at the pumping station, the net cost was 41.6c. per ton.

With dry refuse the clinker varies from 20 to 25% of the refuse, but during July and August it runs from 25 to 30%.

About $3000, or $500 per month, was saved in fuel from Mar. 24 to Sept. 30. Changes at the plant, it is expected, will raise this saving to $600 per month. Operated at full capacity, it is estimated that the fuel saving would be $1000 per month. It may be added that the pumping-station equipment consists of two 10,000,000-gal. Holly-Gaskell duplex compound pumping engines and two cross-compound air compressors, all of which are operated condensing. The destructor-plant steam pressure is carried up to 150 lb. with 100° superheat. As the steam pressure for the pumps is only 90 lb., a reducing valve is used between the destructor and the pumps.

Patching Bituminous Pavements without an Asphalt Plant or a Steam Roller*

By Samuel H. Lea†

The work of patching or repairing holes in the bituminous street pavements of the city of Charlotte, N. C., is carried on by a small repair gang organized from the regular street department forces. The repair work to date has proved quite satisfactory both as to results and cost of execution. It has been done in an economical manner with very little outlay for plant or equipment, and for this reason an account of operations will probably be of

*This article is a supplement to that in "Engineering News" of Dec. 31, 1914, by the same author.

†City Engineer, Charlotte, N. C.

interest, especially to many towns and cities that cannot afford to own an asphalt plant and roller.

Working Methods

Two general methods of making repairs have been employed: One comprises the use of ready-mixed sheet asphalt paving material in the form of "pancakes"; the other consists in filling up the holes in the pavement with successive layers of stone and bituminous material well bonded together. Both of these methods have been followed successfully by the writer in recent repair work in this city; they will be discussed in the order stated.

"Pancake" Method—This method has been described in Engineering News, of Dec. 31, 1914, but it is thought advisable to furnish additional particulars concerning the manufacture of the "pancakes" and the manner of using. The term "pancakes," as used in this connection, is purely local, so far as the writer knows, suggested by the shape of the material when prepared for storage.

The contractor, upon the completion of a recent paving contract, prepared in the usual manner a quantity of

Bituminous Pavement Repair Outfit, Charlotte, N. C.

the regular sheet-asphalt surface mixture. This was taken to a convenient place near the plant and dumped on a previously prepared hard, smooth surface. The hot mixture was raked out and rolled into a sheet of sufficient density to stand handling. It was then cut into blocks or cakes about 24 in. square and 3 in. thick. These cakes were taken to the city stable yard and stored in layers, and covered with canvas for protection.

Pancake material prepared and stored in this manner has been kept for as long a period as two years without deterioration. When needed for use in patching a pavement the pancakes were heated to the proper temperature in a heating pan; the heated material was then placed in a wagon, covered with canvas, and taken to the street for use.

Our present practice is to cut the patch holes quite shallow; sometimes they are not over 1½ in. deep. After being thoroughly cleaned and swept, to remove dust and fine material, the bottom and sides of holes are covered with a paint coat of hot bitumen. This is prepared in a small portable kettle.

The hole after painting is filled with the hot asphaltic mixture, which has been prepared from the pancakes as described. The material is compacted by tamping. The surface of each patch is made convex and a little above the surface of adjacent pavements. For shallow patches and for those of a depth not exceeding 2½ in. the pancake mixture is used alone, but for deeper holes the bottom is filled with 1½ to 2½-in. stone, which has been coated first with hot bitumen; this is tamped thoroughly before the surface mixture is applied.

Patching with Stone and Bitumen—The second method which has been mentioned is used in patching holes in bitulithic and asphaltic concrete pavements. The holes are cut, trimmed and cleaned out in the same thorough manner as has been described for the first method.

The bottom and sides of the hole are covered with a coat of melted bitumen, and a layer of crushed stone is placed in the hole to completely cover the bottom. This is tamped by hand until the stone is solidly embedded in the bottom coating of bitumen, which should be thick enough to envelope the stone. Melted bitumen is then poured over the bottom layer of stone in sufficient quantity to fill all voids and cover the top of the stone.

Another layer of stone is then placed in the hole and tamped as before, covered with bitumen, and the process is repeated until the hole is filled to the top. A final coat of melted bitumen is poured over the top. This is covered with coarse, clean sand and the patch is complete.

The stone used in recent work varied in size from ¾ in. to ½ in. For the deeper holes the largest size stones were used in making the bottom layer, the smaller sizes being placed near the top.

The bituminous material used was a mixture of refined tar and asphalt. In the earlier repair work, the patches were made with refined tar of heavy consistency, used cold. It was soon found, however, that the tar alone did not have sufficient strength or tenacity to stay in place under traffic. The patches so made would flow or creep out of the holes in the direction of heaviest traffic. In some cases there would be a decided hump at one end of a hole with a corresponding depression at the other end. By melting refined tar with a small proportion of asphalt, a mixture of satisfactory consistency was obtained.

Repair Outfit

The equipment used was practically the same for both methods, except that a heating pan was required for the pancake material. The portable outfit comprised a 30-gal. melting kettle, a 1-horse wagon and the necessary tools—a wire push broom, 2 shovels, a pick, 2 paving axes, a smoother, 2 iron tampers and 2 galvanized-iron pails. The repair gang comprised a foreman and two laborers. There were carried in the wagon such supplies as crushed stone, sand, refined tar and asphalt. The accompanying illustration shows the City Engineer, the repair crew and outfit just completing a patch.

Cost Data—The following statement shows the cost of some of this repair work recently done:

Number of patches, 22. Aggregate area, 14.6 sq.yd.	
38 gal. refined tar at 11½c.	$4.38
30 lb. asphalt at 1c.	0.40
¾ cu.yd. crushed stone at $2.25	1.69
1 load of sand	0.90
Labor	5.00
Wagon and mule	2.00
Fuel for heating kettle	0.20
Total	$14.57
Unit-cost of work, $1 per sq.yd.	

Projected Paving Work in Duluth, Minn., for the current year is to cost about half a million dollars.

Engineering Literature

REVIEWS AND NOTES

The First of Three Volumes on Sewerage and Sewage Disposal

REVIEWED BY JOHN H. GREGORY*

AMERICAN SEWERAGE PRACTICE: Vol. I, Design of Sewers —By Leonard Metcalf and Harrison P. Eddy. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 747; 328 illustrations. $5, net.

In presenting this book to the engineering profession the authors have performed a great service. Progress in sewer design was so rapid in the last decade that engineers, in order to keep up with the best practice, have been obliged to follow closely the various engineering publications. The authors have brought together from many a scattered source an immense amount of information, have culled the wheat from the chaff, and have prepared a book that is not only practical but also readable, and one which will remain a standard for many years.

The introduction, mainly historical, treats briefly, but in a most interesting manner, of the early development of sewerage systems, not only in England and on the Continent, but also in the United States. Not the least valuable feature of the introduction is the description of the part played by American engineers, whose names are too well known to be repeated here, in the development of the early sewerage works in this country.

In Chapter I the general arrangement of sewerage systems is taken up and the influence of disposal and of topography on the sewer plan is discussed. A classification of the different kinds of sewers is given, in which each type of sewer is defined, and mention is made of many points to be borne in mind in the laying out of a system of sewers. Under the heading of general details of sewerage systems are considered grades, relief outlets and sewer sections, and examples of methods pursued in making preliminary studies are given.

To the chapter on hydraulics of sewers the authors devote 45 pages. The chapter is well written and the information and data given therein are presented in such a way that they may be quickly used. More than half of the chapter is devoted to a discussion of the well known Kutter formula, and the most uptodate information on the application and limitations of Kutter's formula will be found here. Especially valuable are the data given on the value of n as used by various engineers and in numerous designs. For ascertaining the discharge of circular and egg-shaped sewers, for different values of n, numerous diagrams, conveniently arranged, have been included. Formulas, other than the Kutter, are also considered.

Velocities and grades are taken up in Chapter III and the transporting power of water and the erosion of sewer inverts is discussed. Under minimum grades and velocities the practice in numerous cities as well as that of various engineers is given. The necessity of examining a sewer design with reference to minimum flow conditions is also pointed out.

The measurement of flowing water is treated but briefly. The ordinary formulas for measuring the flow through orifices, over weirs of different kinds and through the Venturi meter, as well as a few convenient tables, are given.

In the chapter on the quantity of sewage to be provided for the authors treat at more or less length the various factors which have to be considered, as population, character of district, proportion of water-supply reaching the sewers, rate of water consumption, ratio of sewage flow to water consumption, ground-water leakage, etc. Many tables and diagrams are given of populations, water consumption and fluctuations in water consumption, as well as data on leakage into sewers and on the actual measured average and maximum flows of sewage in various cities and districts.

In discussing the subject of precipitation the authors first describe various types of rain gages which are in use and give information as to the setting and exposure of gages. The intensity of precipitation is then taken up and many of the formulas which have been proposed, as well as diagrams, giving the relation between the intensity and duration of rainfall in various parts of the country are presented.

Chapters VII and VIII, to which 66 pages are devoted, take up the storm-water problem. Chapter VII opens by giving the best known of the empirical formulas used for estimating the storm-water discharge from drainage areas, and, in the discussion which follows, it is shown by a table and diagrams that these formulas give widely varying results. While the authors do not recommend the use of any empirical formula they recognize that, under certain conditions and for preliminary computations, the use of such a formula may be warranted, and diagrams and tables are given to facilitate the use of the McMath formula which, the authors state, is probably that most favorably known. The question of flood flows from large drainage areas is treated briefly, and numerous flood-flow formulas, as well as records of flood flows in various streams, are given.

The rational method of estimating storm-water runoff is next taken up. The authors have handled this difficult subject exceedingly well. They discuss, in considerable detail, the conditions affecting the rate of runoff, the time required for water to reach the sewers, the time of concentration, the runoff factor and the effect of storage in sewers and upon streets and other surfaces. The application of the rational method is well illustrated by an example in which the drainage of a district is worked out in detail, and a comparison of the design as arrived at by the rational method and by the McMath

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formula is given. The chapter closes with notes giving the basis of design of storm-water drains in various cities, with a discussion of for how severe storms, storm-water drains should be designed and with abstracts of legal decisions relating to flooding of sewers.

In the treatment of the gaging of storm-water flow in sewers descriptions of various types of gages are first given together with suggestions as to their setting. The measurement of storm-water flow is then considered. Tables giving the results of actual measurements in various cities follow the discussion.

To the subject of sewer pipe the authors devote 54 pages. The internal pressure upon the pipes is touched on more or less briefly, but the pressure in trenches and the strength of pipe is considered at length. The best information available has been brought together here. The manufacture of clay and cement pipe is described, and the use of these two kinds of pipe in sewerage work, as well as of reinforced-concrete pipe, steel pipe and flumes, cast-iron pipe and wood-stave pipe, is taken up. Numerous tables have been included, giving data which will be found of much service in the designing of different kinds of pipe sewers.

In Chapter XI the design of masonry sewers is considered and the advantages and disadvantages of the circular, egg-shaped, catenary, gothic, basket-handle, horseshoe, semi-elliptical, parabolic, elliptical, U-shaped, rectangular and semi-circular sections are pointed out, as well as of sections with cunette and of double and triple sections. Diagrams of the hydraulic elements of all of the above mentioned sections are also given to assist in selecting the type of sewer best adapted to meet any given conditions. The effect of space available for construction, the cost of excavation and materials, and stability and imperviousness are touched on. The chapter closes with a list of the best known empirical formulas used for determining the thickness of arches.

The authors devote 58 pages, Chapter XII, to examples of sewer sections and loads on sewers. Tables of dimensions and volume of masonry for many sections are given and these will be found of very material assistance to designing engineers. Especially valuable are the sections of a large number of sewers which have been actually built, accompanied as they are by explanatory notes giving briefly the conditions under which the sewers were constructed. This compilation is probably one of the most complete if not the most complete ever made of American sewer sections. The selection of materials of construction, surface loads transmitted to sewers and weight of backfilling are also considered.

The analysis of masonry arches is treated very fully in Chapter XIII. Three methods of analysis are described in detail—the voussoir arch method, the method based on the elastic theory of the arch, following the method described by Turneaure and Maurer, and the method based on the elastic theory of the arch but using the so-called method for indeterminate structures. Three examples are worked out, one by each method, the three examples being based on the same assumptions so that a comparison of the three methods may be made. The computation of stresses in the arch section is also described, and transverse and longitudinal reinforcement with steel is briefly discussed.

In the next three chapters the details of sewerage systems are taken up. Chapter XIV deals with street inlets, catch-basins, and manholes, Chapter XV with junctions, siphons, bridges and flushing devices, and Chapter XVI with regulators, overflows, outlets, tide gates and ventilation. A large number of details are given, many of which are critically discussed, the advantages and disadvantages being pointed out. These three chapters will be of great assistance to engineers called on to design details.

In Chapter XVII, the last one, the authors devote 75 pages to sewage pumping stations. In many ways this chapter is one of the most interesting and valuable in the book. Not only are a large number of pumping stations illustrated and described but much information regarding pumping machinery is also given.

In the 17 chapters the authors have covered the field of sewer design only, leaving the subjects of sewer construction and sewage disposal for two additional volumes. The book is well printed and is profusely illustrated with well prepared drawings.

Elementary "Electro-Mechanics"

ELEMENTARY ELECTRICITY AND MAGNETISM: A Text-Book for Colleges and Technical Schools—By Wm. S. Franklin and Barry MacNutt. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5x8 in.; pp. viii + 174; 152 illustrations. $1.25, net.

Discriminating readers of new technical books generally expect something more in each new effort of these authors—and they put out new works with fair regularity. In this little volume they have lived up to the expectations of their friends, though before reading the book one is apt to wonder how there can be any excuse for another "brief elementary treatise on electricity and magnetism."

In the first place, the authors have limited their discussions to the mechanical phenomena of electric and magnetic potentials, flows, and fields; they do not discuss the scientific labyrinth of causes and natures. By such an acceptance of physical phenomena as demonstrable facts, comparatively rapid strides are possible for students who have some knowledge of mechanics and chemistry; for instance one is at first surprised to see the laws of electrolysis here employed, though soon it is seen that they are led up to by a natural route. Similar comment is possible on the section taking up the ballistic galvanometer, which as ordinarily presented is a most difficult topic for many students to grasp.

There are some parts of unusual interest and importance—for instance those where strong emphasis is placed on the fact that "generators" do not generate but are mere instrumentalities in the transmission of energy and analogous to a belt pulley. Proper and adequate ideas of energy, power, heat and electricity are not difficult to implant but there is ample evidence that some of these lessons have not been learned by a surprising number of engineers and architects. If their instruction could have been patterned after such a text as this, their mental equipment probably would have been more complete.

The text takes up, first, effects of current—generally and qualitatively covering the production of light, heat, magnetism and chemical change. The phenomena employed in commercial electrical devices and processes are shown. Then chemical effects are taken up more in detail and quantitatively. Heating effects are similarly discussed and this makes necessary the employment of Ohm's Law

and the description of instruments like voltmeters and ammeters. The third section is entitled "Induced Electromotive Force" and here is more about direct-current motors, alternators, transformers, high-tension transmission, telephones, etc. In the fifth and last chapter, "Electric Charge and the Condenser" are developed by mechanical analogues and then extended independently and somewhat mathematically.

A New Edition of Hubbard on Power, Heating and Ventilation

POWER, HEATING AND VENTILATION: A Treatise for Designing and Constructing Engineers, Architects and Students. (In Three Parts, Each Complete in Itself)—By Charles L. Hubbard, Consulting Engineer. Part I, Steam Power Plants. Second edition, fully revised and reset. Pp. ix + 299; 183 illustrations. Part II, Heating and Ventilating Plants. Second Edition, rewritten and reset. Pp. ix + 308; 207 illustrations. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in. $2.50, each.

Two volumes of the new edition of Hubbard's extended treatise on power, heating and ventilation are now available. The changes in publishers has given a good opportunity for complete revision. The former edition (reviewed by the late W. H. Bryan in these columns for Dec. 16, 1909) was a generally commendable text, although there were necessarily a few debatable points and typographical slips. With such a good foundation there has necessarily resulted a good and useful treatise, though it is regrettable that some of the old criticisms still apply to the more general part of the new work.

The first volume presents elementary heat phenomena, use of fuels, steam generation, calculation of boiler capacities, design and construction of commercial boilers and furnaces, calculations of engine capacity, general features of commercial engines, turbines and auxiliary apparatus, and a few details of power-station layout. While the discussions in general are good for an elementary text, yet some details can hardly be passed without comment—for instance, steam tables that do not agree with standard tables embodying recent research, rating tubular boilers at 15 sq.ft. of heating surface per horsepower; giving 30% as the common overload reserve capacity, the recommendation of low rates of coal combustion, conflict between one statement that tubular boilers require 50% per hp.-hr. more coal than water-tube and another statement that all types have about the same efficiency under similar conditions, etc.

Volume II starts out with some elementary explanations of theory and practice in hot-air, hot-water and steam heating. A scheme is outlined for estimating probable heat loss from structures. Much of this method is empirical and good judgment and experience are essential for satisfactory results; trend toward too low figures is probably helped by a table of transmission losses in which the dissipated B.t.u.'s go up not quite proportional to temperature difference, whereas actually the loss rises a little faster.

A chapter on ventilation describes common impurities in room air, the quantity of fresh air commonly supplied, cleaning, distributing, etc. It should be noted that the older criticised figures for quantity needed have been retained without change; these are high in regard to observed practice in schools, assemblies, etc. (though that may be the fault of common practice) and are low in regard to the changes of air per hour for public rooms. There is no discussion of re-circulated air, now being extensively studied, or of the cost of artificially securing the ventilation obtainable with open windows. A couple of pages are devoted to the use of anemometers in air measurements but no hint is given that the anemometer is a generally discredited and unreliable instrument.

Following this more general matter, are the chapters on hot-air furnaces, steam and hot-water boilers, fittings, direct and indirect steam heating, hot-water systems with gravity and forced circulation, exhaust-steam systems, fans, hot-blast heating and ventilation, special devices, special building services, and care and management. These deal with actual equipment now for sale and are comprehensive, practical and eminently useful though not above criticism in some minor details.

ELEMENTARY MATHEMATICAL ANALYSIS; A Text Book for First Year College Students—By Charles S. Slichter, Professor of Applied Mathematics, University of Wisconsin. [Modern Mathematical Texts.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. xiv + 490; 183 text illustrations. $2.50, net.

For any engineer who is ten years or more out of college this book is to be regarded as a very desirable piece of recreation and instruction reading. Its new and useful feature lies in the point of view, which is distinctly different from that of other mathematical texts. Lacking the mathematical instinct, we are unable to define this peculiar point of view. Professor Slichter himself states it in the preface as follows: "The emphasis of the book is intended to be upon the notion of *functionality*." Whatever this may mean, we guarantee that the reader will come through with a very notable gain in the breadth of his mathematical knowledge. For instance, he will find the introduction to complex numbers particularly easy. Also he will come nearer to having the power of recognizing the form of an algebraic curve on sight.

LACKAWANNA STEEL COMPANY'S HANDBOOK for Engineers, Architects and Builders—Containing General Information, Together with Diagrams, Dimensions and Weights of Structural Steel Sections, Special Shapes, Merchant Bars, Steel Sheet Piling, Standard Heavy and Light Rails, Track Accessories, etc., Manufactured by the Company, Buffalo, N. Y. 1915 Edition. Flexible leather; 4x7 in.; pp. 456; illustrated. $2.

To the selection of matter customary in steel-mill handbooks this one adds considerable information on Lackawanna interlocking steel sheetpiles and also on light rails. For rails and splice-bars (but not for other sections) the weights and dimensions are given in metric as well as in foot-inch measure. There are very full tables of the capacities of built columns, both box and I-section. For many users these tables will not be quite as convenient as they might be, as they are based on a formula of the Gordon type, while most specifications now call for a straight-line formula. Among the general tables at the end of the book, special attention seems to have been given to tables for converting metric into English measures and the reverse.

A full report of the Conference of American Mayors on Public Policies as to Municipal Utilities, held at Philadelphia, Penn., Nov. 12-14, 1914, occupies nearly all of the 357 pages of "The Annals of the American Academy of Political and Social Science" for January, 1915 (36th St. & Woodland Ave., Philadelphia, Penn.). Most of the papers and discussions dealt with state and local regulations of public utilities and with municipal

ownership. Besides mayors, a number of members of public-service commissions, economists and publicists took part in the proceedings.

Wood Preservation

REVIEWED BY F. J. ANGIER*

THE PRESERVATION OF STRUCTURAL TIMBER—By Howard F. Weiss, Director, Forest Products Laboratory, U. S. Forest Service. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiii + 312; 32 illustrations. $3, net.

Mr. Weiss, with his corps of able assistants at the Forest Products Laboratory at Madison, has contributed many valuable data to the wood-preserving industry.

In his introduction the author takes up the definition and importance of wood preservation and gives the present standing of the wood-preserving industry in the United States. He then discusses the factors which cause the deterioration of structural timber; the effect of the structure of wood upon its injection with preservatives; the preparation of timber for its preservative treatment; the processes used, together with a description of the different preservatives; the construction and operation of wood-preserving plants; and the prolongation of the life of all kinds of timber from decay and attack by insects. A chapter is devoted to the strength and electrolysis of treated timber and another to the use of substitutes for treated timber and to the protection of timber from fire. In the appendixes he gives a description of the many different preservative processes and a list of the United States patents from the early part of the nineteenth century. The book is well written, has a good index, is excellently printed, and is of equal value to the experienced operator in timber preservation and to the beginner.

STEAM CHARTS, Also a Table of Theoretical Jet Velocities and the Corrections of Mercury Columns, with Fifty Illustrative Problems—By F. O. Ellenwood, M. Am. Soc. M. E., Assistant Professor of Heat Power Engineering, Cornell University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 7x10 in.; pp. iv + 91; illustrated. $1, net.

The 12 steam charts here given are plotted between "B.t.u. per lb." and "Cu.Ft. per lb." and show lines of constant-pressure, constant-quality and constant-entropy values. These charts, if put together, would form a larger chart in which the heat-content range would be from 725 to 1510 B.t.u. per lb. and the volume would run between 1.16 and 2340 cu.ft. per lb. In one corner of every other chart are plotted curves for "heat of the liquid" for all pressures. Two additional plates give the external work done during the constant-pressure formation of steam from water at 32° F. A large-type table gives theoretical velocities of steam expanding in a frictionless nozzle.

Besides the tables, the book contains a limited text on thermodynamics. Under "fundamental principles" are brief explanations of pressure-volume and temperature-entropy diagrams, adiabatic expansion and compression, intrinsic energy, steam formation at constant pressure, heat of the liquid, total heat, saturation curves, properties of superheated steam, etc. The preparation and use of the steam charts is explained in detail. Text and tables on barometric corrections for temperature, altitude, gravity variation and capillarity are given prominent place.

The author has built up a convenient tool for those engineers who have to make many calculations in which enter the properties of saturated or superheated steam. The charts are plotted on sufficiently large scale to be accurate and easily read. The range of the charts is larger than the common-usage requirements of today and this gives a reserve for future developments. The subdivision into page units makes the set easy to handle. The main coördinates used give probably better defined values from the curves than those of the familiar charts based on heat and entropy.

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City Planning

MODERN CITY PLANNING AND MAINTENANCE—By Frank Koester, author of "Steam Electric Power Plants," "Hydroelectric Developments and Engineering" and "The Price of Inefficiency." New York: McBride, Nast & Co. Cloth; 7x10 in.; p. xix + 329; 200 illustrations. $6, net.

CARRYING OUT THE CITY PLAN: The Practical Application of American Law in the Execution of City Plans—By Flavel Shurtleff, of the Boston Bar, in collaboration with Frederick Law Olmsted, Fellow, American Society of Landscape Architects. New York: Survey Associates, Inc., 105 E. 22d St. Cloth; 5x8 in.; pp. ix + 349. $2, postpaid.

By broadening the title and scope of his volume beyond that of the usual work on city planning Mr. Koester has taken in not only such topics as civic centers, street systems, harbors, bridges, transportation and garden cities, but also practically the whole range of municipal activities. With so ambitious a program, the treatment of many of the topics is necessarily brief. Thus, in fifty pages on "City Construction and Maintenance" we have notes on street construction, sewers, care of streets, refuse disposal, water-supply, gas-supply, electric generating plants and electric street railways.

The many halftone views are handsomely reproduced, the plans and diagrams are generally satisfactory, the type is large and the presswork and binding good.

Although the book falls short of the author's pretentious claims for it in his preface, it should be serviceable to many who are without other books on city planning and who wish at the same time to get a general idea of that subject and of municipal public works as a whole. Serious students of city planning would be better served by Robinson's "Modern Civic Art" or by one of two recent British works, Unwin's "Town Planning in Practice" and Trigg's "Town Planning." The book now before us is more fully illustrated than any of the three just named but is essentially a compilation, while the books by Robinson, Unwin and Trigg are written by men of experience and reputation as town planners.

The legal and certain administrative aspects of town planning are reviewed by Mr. Shurtleff, with special reference to the diverse statutory and constitutional provisions which are so marked a feature of municipal affairs in the United States. The value of the study is increased by comparisons of fundamental American and European principles and practice. Mr. Olmsted had a guiding hand in the collection of the material and in shaping the conclusions drawn.

The main topics of the book are methods of public acquisition of land and the distribution of its cost, excess condemnation, the use of the police power and the work of administrative agencies in the execution of the city plan. Useful appendixes cite American legislation and court decisions in detail and give extracts from a report on English and Continental systems of taking land for public purposes. The chapter on administrative agencies

contains a list of cities having official planning commissions.

In discussing assessments for benefits the author appears to have overlooked some of the most valuable material on the subject—perhaps because it was so close at hand. We refer to the illuminating report on sewer assessments prepared some twenty years ago by F. Herbert Snow for Brockton, Mass., and to the symposium on the same general subject presented a few years later before the Boston Society of Civil Engineers and printed in the "Journal of the Association of Engineering Societies."

Irrigation on the Farm

USE OF WATER IN IRRIGATION—By Samuel Fortier, Chief of Irrigation Investigations, Office of Experiment Stations, U. S. Department of Agriculture. New York and London: McGraw-Hill Book Co., Inc. [Agricultural Engineering Series.] Cloth; 6x9 in.; pp. xiii + 265; 71 illustrations. $2, net.

THE PRINCIPLES OF IRRIGATION PRACTICE—By John A. Widtsoe, President of the Utah Agricultural College. New York: The Macmillan Co. London: Macmillan & Co., Ltd. [The Rural Text-Book Series.] Cloth; 5x8 in.; pp. xxv + 496; 179 illustrations. $1.75, net.

These two books are in a measure supplementary, either one to the other, according to the main interest of the reader. Mr. Fortier, as his title implies, deals primarily with the use of water in irrigation and Mr. Widtsoe with agriculture aided or made possible by irrigation. The general run of engineers will find Mr. Fortier's book of more interest and value than the one by Mr. Widtsoe, unless they are in more need of information on the agricultural than on the engineering phases of irrigation.

Mr. Fortier takes up in succession the irrigated farm, equipment and structures, methods of preparing land and applying water, water waste, measurement, delivery and duty, and the irrigation of staple crops.

Mr. Widtsoe, with more space at his disposal, has four chapters on water and soils, six on water and plants, five on irrigated crops, and five on "miscellaneous" topics. The latter deal with the duty, measurement and division of water, over-irrigation and alkali, irrigation in humid climates, tools and devices, irrigation history, and permanent agriculture under irrigation—subjects to which the larger part of Mr. Fortier's book is devoted. Appendixes contain some tables of water constants and Cippoletti weir discharges. Reference lists are appended to each chapter of Mr. Widtsoe's book.

Each book contains a goodly number of well chosen illustrations. Naturally, Mr. Fortier gives more of these which will be directly useful to the engineer than does Mr. Widtsoe.

A subject not mentioned by Mr. Fortier and inadequately treated by Mr. Widtsoe is the use of sewage for irrigation. Strangely enough, the latter, while mentioning sewage irrigation at Edinburgh, Scotland, and at Milan, Italy, does not direct attention to any of the American sewage farms, the chief of which has been owned and operated for years past by Pasedena, Calif.; nor does he list in his references Rafter's two Water Supply and Irrigation Papers (U. S. Geological Survey) on Sewage Farming.

Mr. Fortier's remarks on insuring the purity of drinking water on irrigated farms are inadequate and to some may be misleading.

Finally, each book will doubtless be accorded a welcome, Mr. Fortier's as one of a new "Agricultural Engineering Series" being brought out under the consulting editorship of E. B. McCormick, Mechanical Engineer, Office of Public Roads, Washington, D. C., and Mr. Widtsoe's as an addition to "The Rural Text-Book Series" which has been appearing for some years past with L. H. Bailey, of Ithaca, N. Y., as editor.

THE MECHANICAL PROPERTIES OF WOOD; Including a Discussion of the Factors Affecting the Mechanical Properties and Methods of Timber Testing—By Samuel J. Record, Assistant Professor of Forest Products, Yale University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 165; 54 illustrations. $1.75, net.

Written as a textbook, this little work nevertheless can serve as a useful manual on the strength of wood and the various factors which influence it—from moisture to parasites and preservatives. For the engineer's purposes, the second half of the book, dealing with timber testing and related matters, is probably not necessary, and except for a set of important tables at the back of the book all that follows p. 87 is of service mainly for instruction purposes. Some engineering readers may find themselves suspicious of the figures given by the author, when they note that the strength of cast iron and "high-grade bessemer steel" is quoted from tests made half a century ago, and when they run across the statement that "in a wooden truss bridge the tension members are steel rods." However, all the figures and experimental facts concerning wood given in the book are based on recent and authoritative work, as the investigations of the Forest Service, and thus merit entire confidence.

HANDBOOK OF TABLES AND FORMULAS FOR ENGINEERS—Compiled by Clarence A. Peirce, Instructor in Power Engineering, with Mathematical Sections by Walter B. Carver, Assistant Professor of Mathematics, Cornell University. New York and London: McGraw-Hill Book Co., Inc. Flexible leather; 4x7 in.; pp. x + 168; illustrated. $1.50, net.

As a useful and compact little compendium of mathematical notes and tables—logarithms, roots, integrals, plane curves, etc.—this book will find many friends. A chapter on laws and formulas of mechanics, and tables of physical and chemical properties of substances, will also be appreciated. There are also a few pages on gages, bolt and nut dimensions, pipe fittings, and the like, as a special feature, and a Mollier entropy chart; some of this matter is not congruous with the rest of the book, but its inclusion does not seriously reduce the utility of the work.

STRENGTH OF MATERIALS—By Arthur Morley, M. I. Mech. E. Third edition. New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. ix + 497; 244 illustrations. $2.50, net.

As a well-written treatise on the strength of materials this work claims a place among the rather few English textbooks of quality that appeal to the American engineer. It deals with a number of problems not found in the ordinary college text on applied mechanics; among them curved members, pipes, disks, flat plates, etc. The moment area method is used to a considerable extent, following a tendency also evident in this country.

COAL GAS RESIDUALS—By Frederick H. Wagner, M. Am. Soc. M. E., author of "Blast-Furnace Gases." New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xi + 179; 44 illustrations. $2, net.

A book on coal-tar products and processes is of timely interest in view of the present inquiries into our failure to build up an American coal-tar dye and drug industry and our reliance largely on German plants. The author here

gives some fundamental information about the chemical and physical properties and common uses of the leading recovery products of coal and producer gas—tar pitch and oils, naphthalene, cyanogen, ammonia and benzol. But the most of the book is devoted to describing and discussing the processes and appliances used in recovering these compounds. Particular stress is laid on the work of Walther Feld whose greatest feat was the evolution of a system for simultaneously freeing gas from tar and separating the crude tar into group constituents. There are many data on recovery plants in America and abroad.

MATERIALS OF MACHINES—By Albert W. Smith, Director of Sibley College, Cornell University. Second edition, rewritten. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. v + 215; 36 illustrations. $1.25, net.

Prof. Smith has revised his very interesting brief treatise on metallic materials, adhering in general to his original plan. The first part contains a review of the use of fuels, descriptions of electrical furnaces, a catalog of refractories and an outline of the metallurgy of iron, steel, copper, tin, zinc, etc. The second part gives an elementary discussion of stresses, strains and testing methods, and reviews the chemical and mechanical properties of iron, steel and non-ferrous alloys. A final chapter very concisely gives the particular services for which such metals as high-speed tool and other special steels, wrought iron, malleable cast iron, bronzes, white metal, etc., would be selected.

Some interesting illustrated historical and descriptive notes on cast-iron pipe, together with standard specifications and a variety of useful tables, occupy a considerable portion of the new general catalog of the United States Cast-Iron Pipe & Foundry Co. (Burlington, N. J.).

Rules for "Setting, Repairing and Testing Water Meters" have been published as a 16-page illustrated pamphlet by the Buffalo Meter Co. (290 Terrace, Buffalo, N. Y.). They contain much information of use to waterworks men having to do with meters.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale, and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION—Report of the Proceedings of the 47th Annual Convention, Atlantic City, N. J., June 15-17, 1914. Chicago, Ill. (1112 Karpen Bldg.): Jos. W. Taylor, Secy. Cloth; 6x9 in.; illustrated. Part 1, pp. 660; Part 2, pp. 661-1045.

AMERICAN SEWERAGE PRACTICE: Vol. II, Construction of Sewers—By Leonard Metcalf and Harrison P. Eddy. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 564; 181 illustrations. $4, net.

ANNUAL REPORT OF THE RIVERS AND LAKES COMMISSION OF ILLINOIS, 1913-1914—Chicago: The Commission, Room 1534, 608 S. Dearborn St. Cloth; 6x9 in.; pp. 60; illustrated.

The Commission has broad supervisory control of all the waters of Illinois, as regards use for navigation, power, sewage disposal and the preservation of natural beauties.

DIE BETRIESBUCHFUHRUNG EINER WERKZEUGMASCHINEN-FABRIK PROBLEME UND LOSUNGEN—Von Dr.-Ing. Manfred Seng. Berlin: Julius Springer. Cloth; 8x11 in.; pp. vi + 87; 3 text figures and 41 blank forms. 5 marks.

CANADIAN "WATER RESOURCES PAPERS"—Ottawa, Ont.: Water Power Branch, Department of the Interior, Canada. Paper; 7x10 in.; illustrated.

No. 1: Railway Belt Hydrographic Survey for 1911-12—By P. A. Carson, Chief Engineer. Pp. 551.

No. 7: Manitoba Water Powers—By D. L. McLean, S. S. Scovil and J. T. Johnston, for the Manitoba Public Utilities Commission. Pp. 214.

THE CREATION OF WEALTH: Modern Efficiency Methods Analyzed and Applied—By J. H. Lockwood. Cincinnati, Ohio: Standard Publishing Co. Cloth; 5x8 in.; pp. 225. $1, net.

ELEMENTS OF HYDRAULICS—By S. E. Slocum, Professor of Applied Mathematics in the University of Cincinnati. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xi + 294; 210 illustrations. $2.50, net.

FINAL REPORT OF THE CONSTRUCTION OF THE TUMALO IRRIGATION PROJECT to the Desert Land Board of the State of Oregon—By O. Laurgaard, Project Engineer, Laidlaw, Ore. Paper; 6x9 in.; pp. 90; illustrated.

FLOOD PROTECTION IN INDIANA—By W. K. Hatt, Professor of Civil Engineering, Purdue University; Chief Engineer, Indiana Flood Commission. Indianapolis, Ind.: Indiana Bureau of Legislative Information, State House. Bulletin No. 4. Paper; 5x8 in.; pp. 50; illustrated.

An abstract, in nontechnical language, of the forthcoming report of the Commission. No recommendations are included.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE—Edited by George C. Lloyd, Secretary. No. II, 1914, Vol XC. London: Offices of the Institute, 28 Victoria St., and E. & F. N. Spon, Ltd. New York: Spon & Chamberlain. Cloth; 6x9 in.; pp. 448.

KANSAS STATE BOARD OF HEALTH—Seventh Biennial Report, or the 29th and 30th Annual Reports, from June 30, 1912, to June 30, 1914. Topeka, Kan.: S. J. Crumbine, M. D., Secretary. Cloth; 6x9 in.; pp. 184.

LEGAL PRINCIPLES OF PUBLIC HEALTH ADMINISTRATION—By Henry Bixby Hemenway, M. D., Fellow, American Academy of Medicine; Fellow, American Medical Association; Member, American Public Health Association; Member, American Association of Railway Surgeons; Member, American Statistical Association. Introduction by John Henry Wigmore, Dean, Northwestern University Law School; Illinois Commissioner on Uniform State Laws. Chicago: T. H. Flood & Co. Cloth; 6x9 in.; pp. xxxvi + 859. $7.50, net.

LIST OF WORKS IN THE LIBRARY RELATING TO OXY-ACETYLENE WELDING—New York Public Library, Fifth Ave. and 42d St. Paper; 7x10 in.; pp. 34.

NATIONAL STANDARD HOSE COUPLINGS AND FITTINGS FOR PUBLIC FIRE SERVICE—Washington, D. C.: U. S. Bureau of Standards. Circular No. 50. Paper; 7x10 in.; pp. 23; illustrated.

Reviews the movement for standardization begun in 1873, following the Boston fire of 1872; gives the standards for hose couplings and for the operating nut for hydrant stems adopted by a dozen national societies; and gives a list of 287 cities which have adopted the national standard.

NEW TIME SAVERS IN HYDRAULICS AND EARTHWORK—By C. E. Housden, Late Superintending Engineer, Public Works Department, India, and Sanitary Engineer to the Governments of Burma and Eastern Bengal and Assam. New York and London: Longmans, Green & Co. Cloth; 5x7 in. $1, net.

Part I: Scales for Ascertaining the Dimensions of Pipes, Drains and Sewers. Pp. 16; 5 plates. Published separately, as noted under "Publications Received," Engineering News, Sept. 17, 1914, p. 614. 60c.

Part II: Rapid Earthwork Calculation. Pp. 31; 4 plates. Published separately, as noted under "Publications Received," Engineering News, Dec. 24, 1914, p. 1288. 50c.

In his preface to Part I, the author states that the "Scales" are taken from his "'Water Supply' and 'Drainage' Systematized and Simplified, in which work their construction is fully explained." A review of this book was published in Engineering News, Feb. 13, 1913, p. 331.

Part II is claimed by the author to embody improvements in earthwork calculation suggested by a careful reconsideration of his "Practical Earthwork Tables," reviewed in Engineering News, Apr. 16, 1908, p. 441.

THE PRODUCTION OF IRON ORE, PIG IRON AND STEEL IN 1913—By Ernest F. Burchard. (Part I of "Mineral Resources of the United States, 1912.") Washington, D. C.: U. S. Geological Survey. Paper; 6x9 in.; pp. 291-338; illustrated.

STRUCTURAL ENGINEERING—By J. E. Kirkham, Professor of Structural Engineering, Iowa State College; Consulting Bridge Engineer, Iowa Highway Commission; formerly Designing Engineer with American Bridge Co. Chicago: The Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd. Cloth; 6x9 in.; pp. iv + 669; 452 text illustrations. $5, net.

STRUCTURAL STEEL DRAFTING AND ELEMENTARY DESIGN—By Chas. D. Conklin, Assoc. M. Am. Soc. C. E., In Charge of Structural Design, Cooper Union Schools, New York City. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 9x12 in.; pp. vii + 154; 151 illustrations. $2.50, net.

WATER-SUPPLY PAPERS, U. S. GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.

No. 330: Surface Water Supply of the United States, 1912: Part X, The Great Basin—By F. F. Henshaw, E. A. Porter and G. C. Stevens. Pp. 275.

No. 335: Geology and Underground Waters of the Southeastern Part of the Texas Coastal Plain—By Alexander Deussen. Pp. 365.

No. 348: Profile Surveys in Hood and Sandy River Basins, Oregon—Prepared under the Direction of R. B. Marshall, Chief Geographer. Pp. 8.

No. 366: Profile Surveys of Snoqualmie, Sultan and Skykomish Rivers, Washington—Prepared under the Direction of R. B. Marshall.

Field and Office

Straightening a Tall Leaning Factory Chimney by a New Method

By Thomas S. Clark*

In the past many methods have been employed to bring back to the vertical position tall columns such as chimneys, shafts, towers, and the like, which after construction have leaned or settled out of plumb. The procedure has often been very expensive and hazardous as well as slow; in the case of chimneys it has necessitated shutting down the boilers and a consequent loss in output of the manufacturing plant. A new, unique and inexpensive method was recently employed to straighten quickly a 100-ft. factory chimney in Brooklyn, N. Y., without interruption to the plant.

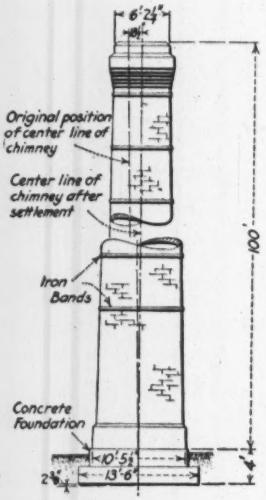


Fig. 1. Leaning Chimney in Brooklyn, 100 Ft. High

The Problem

Under one side of the foundation the soil had softened, and settlement had taken place, due to leakage from a water pipe near the foot of the foundation whose existence had been forgotten. Fig. 1 shows the leaning chimney.

To excavate on the low side of the foundation to the depth of the footing course, crib under it, and attempt to jack the structure back plumb, would have involved large cost, loss of time, and not a little risk. The great weight of the 100-ft. column and the additional pressure due to the leaning would have required powerful jacks and a substantial footing to jack against. There would have been danger also of cracking the unreinforced spread foundation, and additional foundation would have had to be placed before the jacks and cribbing could have been removed safely.

Another method to straighten a leaning chimney, employed to some extent in Europe, is to saw out a course—or a portion of a course—of brickwork on the side of the columns away from the direction of lean, in wedge-shape with an ordinary two-man crosscut saw, and allow the portion of the chimney above the cut to settle back. This method is, to say the least, not entirely satisfactory nor does it remedy the defect entirely, as the portion below is still out of plumb and the bearing surface of the foundation footing is not brought to the horizontal. For these reasons these two methods were abandoned.

The chimney was in operation, so it was not possible to determine the amount of its lean by plumbing to a center on the inside. The deviation from the vertical was therefore determined with a transit by a simple triangulation; it was found to be 18½ in. From this figure, with the known height of the chimney, it was determined that the toe of the footing on the high side must be settled 2⅜ in. on a line exactly opposite the direction of the lean. The problem was to remove just enough earth between the center of the foundation and the toe of the high side to gradually settle the foundation back 2⅜ in. at the toe. Levels were taken on the high side and an indicating plumbline fastened to the side of the chimney.

How the Work Was Done

A trench was excavated on the high side to the depth of the foundation, about 4 ft., the length of the trench equal to the square side, and its width equal to half the width of the foundation, or about 8 ft. Four 2-in. wrought-iron pipes, 8 ft. long (half the width of the foundation), were sharpened sawtooth fashion at one end. These pipes were successively driven under the high side of the foundation near its center (Fig. 2), then withdrawn, and emptied of the material in them by driving a steel rod through the pipe. Successive insertions were made about a foot apart. As the pipes were withdrawn, the earth adjacent to the pipes crushed into the holes left by the withdrawn pipes.

In this way but a small quantity of earth was removed at a time, and but a small quantity gave way at a time;

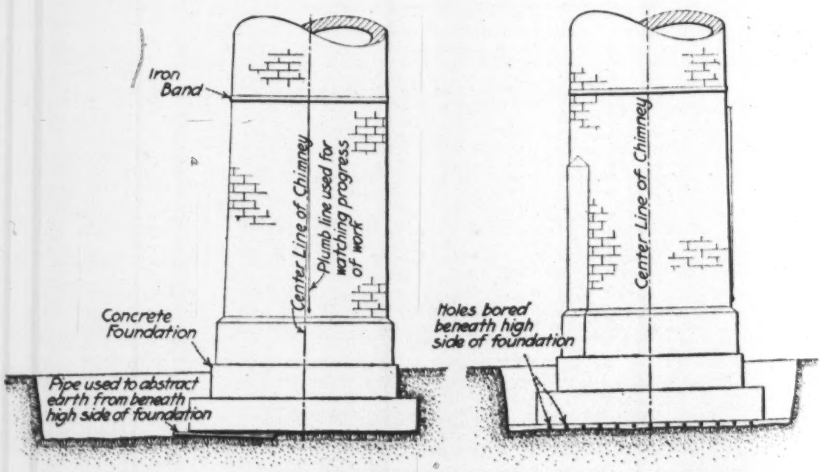

Iron Band
Center Line of Chimney
Plumb line used for watching progress of work
Concrete Foundation
Pipe used to abstract earth from beneath high side of foundation
Holes bored beneath high side of foundation
Center Line of Chimney

Fig. 2. Method of Removing Earth under High Side to Bring the Chimney Back to Plumb

*Engineer, Alphons Custodis Chimney Construction Co., 99 Nassau St., New York City.

the yielding occurred just where wanted. The chimney settled back gradually, with no shock or no danger. The amount of settlement, its direction, and the rapidity of settlement were always in absolute control. The telltale plumb-bob gave the direction as well as the amount of movement.

At one period of the operation, the chimney began to settle slightly out of line. It was only necessary to drive the pipes more often at a certain point to bring the shaft back to line.

When the column was again plumb, the trench was filled up. The underground leak in the drain pipe had been previously stopped to prevent further softening of the earth on one side. The chimney has since remained intact.

The work was done by the Alphons Custodis Chimney Construction Co., of New York. The method was devised by the writer, in that company's employ.

Specifications for Uniform Screens for Soil Tests*

The following specifications for screens have been adopted by a Committee of the American Society of Civil Engineers on Bearing Power of Soils for Foundations, in an attempt to classify soils by screen tests:

UNIFORM SCREEN SPECIFICATIONS

The screens shall be made of wire cloth, plain woven (not twilled) from brass, bronze, or other suitable wire, and mounted on frames without distortion. Wire coarser than 0.07 in. diameter shall be made with an extra crimp between wires. The diameters of the wires shall be as given in Col. 3 of the accompanying table, and the average diameter of such wires as may be measured shall not be outside the limits given in Cols. 4 and 5.

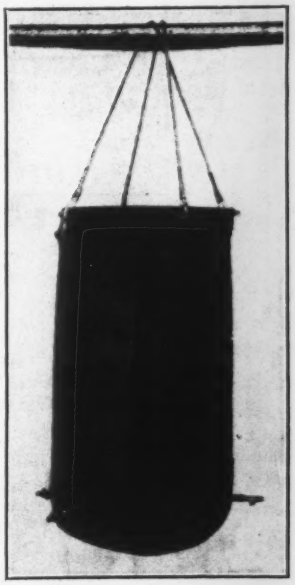
The number of warp wires per whole inch as measured at any point of the screen shall not be outside the limits given in Cols. 6 and 7, an dof the shoot wires as given in Cols. 8 and 9. For screens No. 100 and finer the measurements for ¼-in. intervals shall be as given in Cols. 10, 11, 12 and 13. Screen No. 3 and finer screens shall have the number of wires per inch equal to the screen number.

MEASUREMENTS OF SCREENS

The average diameter of the wires shall be obtained by measuring a sufficient number, by means of a micrometer microscope. Measurements made with the micrometer caliper will be sufficiently accurate for wires having a diameter of 0.025 in. or larger. The No. 20 screen and finer shall be measured by means of a graduated glass scale laid on the screen, readings being taken over several inch intervals, including readings at each ¼-in. point. For screens coarser than No. 20, readings shall be taken for full-inch intervals only. Screens coarser than No. 4 will have the specifications shown in footnote of the table, and the determination of opening may be made by means of a micrometer microscope or accurate inside caliper.

*Presented in a report to the American Society of Civil Engineers, Jan. 20, 1915.

A Water-Disinfecting Outfit for Field Use consisting of a canvas bag as a water-holder and canteen-filler, and a carton of sealed glass tubes containing calcium hypochlorite, has been gotten up by Major William Lyster of the United States Army. The bag is of special-woven flax canvas, 20-in. diameter and 28 in. long. At the top it is sewed to a flat galvanized-iron ring, hinged so as to fold in half. At the bottom are five self-closing nickel faucets, from each of which a canteen may be filled in ten seconds.



WATER-STERILIZING BAG AND CANTEEN FILLER

The bag is to be used only in a stationary position, when it may be suspended by ropes, as shown by the view. When filled it weighs about 330 lb. When empty its weight is 7 to 7½ lbs.; it may then be folded into a convenient package, ready for transportation.

The calcium hypochlorite used for disinfection is put up in ¾x3-in. sealed glass tubes, 60 of which, weighing only 10 oz. altogether, are packed in a 7½x3½x4¼-in. corrugated paper carton. The tubes are marked with a file so as to be readily broken without splintering the glass. Each tube contains 14 to 16 grains of calcium hypochlorite, containing 30 to 32% effective chlorine, or just enough to treat one filling of the water bag at the rate of 1 to 500,000. Bacterial tests have shown that with this dosage 15 minutes of contact kills most of the amoebæ causing dysentery, and 30 minutes all of them, and that usually water so treated is safe to drink in 5 to 10 minutes. The use of a filter cloth placed over the mouth of the bag in filling is recommended, as the hypochlorite acts more readily on clear water than on that containing suspended matter.

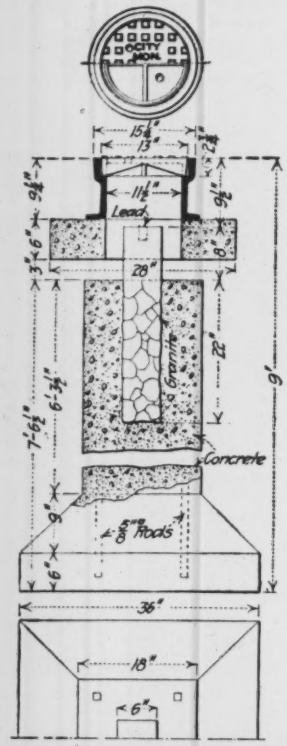
Although designed primarily for army use, the equipment described would be just as serviceable for any other bodies of men on the move where lightness of baggage is important.

TABLE OF UNIFORM SCREEN SPECIFICATIONS

Screen Scale Ratio 1.414 = 2		Diam. Wire	Limits of Wire Diams.		Limits for Number of Openings							
					For Any Whole Inch Interval				For Any Quarter-Inch Interval			
			Warp	Shoot	Warp		Shoot		Warp		Shoot	
Screen No.	Opening In.	In.	In.									
1	2	3	4	5	6	7	8	9	10	11	12	13
8°	4.198	0.375	0.376	0.374								
7°	2.969	0.207	0.208	0.206								
6°	2.099	0.192	0.193	0.191								
5°	1.485	0.149	0.1498	0.1482								
4°	1.050	0.149	0.1498	0.1482								
3°	0.742	0.135	0.1358	0.1342								
2°	0.525	0.105	0.1058	0.1042								
1°	0.371	0.092	0.0928	0.0912								
3	0.263	0.070	0.0707	0.0693								
4	0.185	0.065	0.0657	0.0643	4.05	3.95	4.05	3.95				
6	0.131	0.036	0.0366	0.0354	6.05	5.95	6.05	5.95				
8	0.093	0.032	0.0326	0.0314	8.125	7.875	8.125	7.775				
10	0.065	0.035	0.0355	0.0345	10.125	9.875	10.125	9.875				
14	0.046	0.025	0.0255	0.0245	14.25	13.75	14.25	13.75				
20	0.0328	0.0172	0.0177	0.0168	20.5	19.5	20.5	19.5				
28	0.0232	0.0125	0.0129	0.0121	28.5	27.5	28.5	27.5				
35	0.0164	0.0122	0.0126	0.0198	35.5	34.5	35.0	34.0				
48	0.0116	0.0092	0.0095	0.0089	49.0	47.0	49.0	47.0				
65	0.0082	0.0072	0.0075	0.0069	66.0	64.0	66.0	64.0				
100	0.0058	0.0042	0.0045	0.0039	101.0	98.0	102.0	96.0	101	95	103	93
150	0.0041	0.0026	0.0028	0.0024	151.0	146.0	153.0	144.0	152	144	154	142
200	0.0029	0.0021	0.0023	0.0019	202.0	195.0	205.4	192.0	203	192	205	190

NOTE—Limits for openings in inches for larger sizes are as follows:

8°	4.218	4.178	5°	1.495	1.475	3°	0.752	0.732	1°	0.381	0.361
7°	2.989	2.949	4°	1.060	1.040	2°	0.535	0.515	No. 3	0.270	0.256
6°	2.114	2.084										



The monuments are constructed of California granite free from defects. Each one is 6" square and 2'-6" or 3'-6" long as desired. The top of each monument is dressed 6" square for a depth of 8" for the shorter and 6" for the longer monument, the balance of the stone is roughly squared without being dressed and nowhere less than 6" square. In the center at the top of the monument is drilled a hole 1" diam. and 2" deep, slightly larger at bottom than the top. This hole is filled with melted lead which when cooled must be calked tight.

FIG. 1, SAN FRANCISCO, CAL.

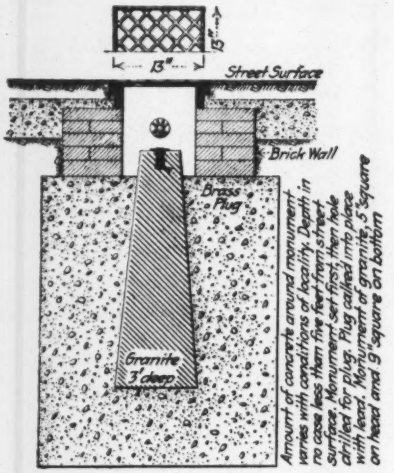

13"
1½"
Street Surface
Brick Wall
Brass Plug
Granite 3' deep
Amount of concrete around monument varies with conditions of locality. Depth in no case less than five feet from street surface. Monument set first, then hole drilled for plug. Plug cailked into place with lead. Monument of granite, 5" square on head and 9" square on bottom

FIG. 2, WILMINGTON, DEL.

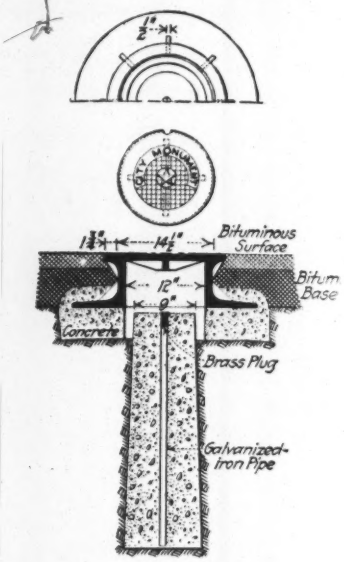


FIG. 3, EL PASO, TEX.

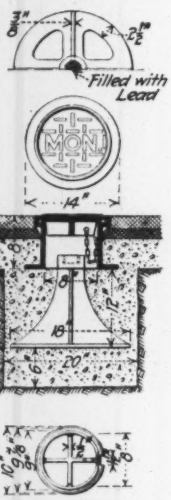


FIG. 4, TACOMA, WASH.

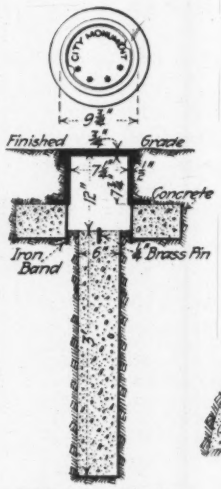


FIG. 5, OAKLAND, CAL.

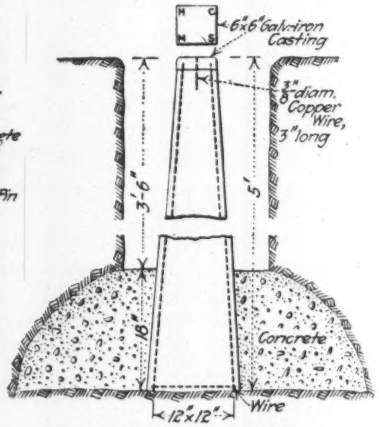


FIG. 6, HARTFORD, CONN.

FIG. 1 TO 6, CITY SURVEY MONUMENTS

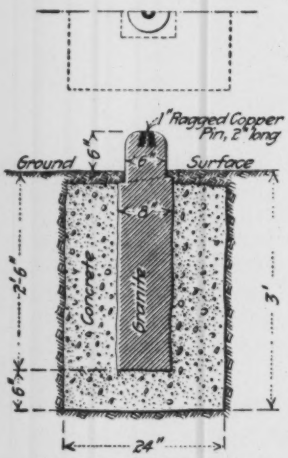


FIG. 7, NEW ORLEANS, LA.

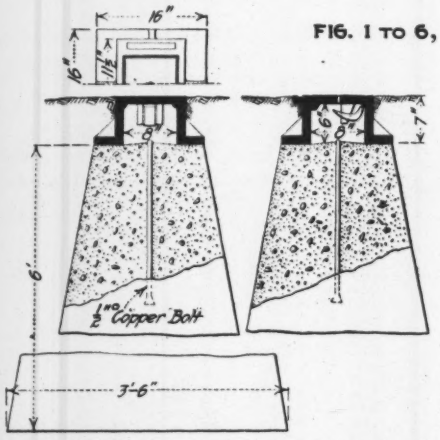


FIG. 8, CHICAGO, ILL.

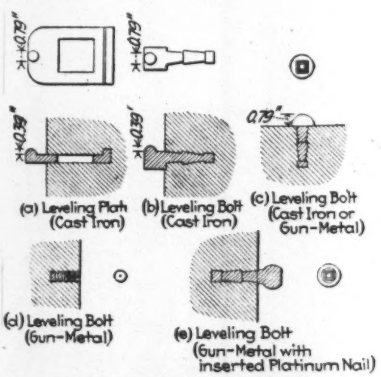

0.79"
0.79"
0.79"
(a) Leveling Plate (Cast Iron)
(b) Leveling Bolt (Cast Iron)
(c) Leveling Bolt (Cast Iron or Gun-Metal)
(d) Leveling Bolt (Gun-Metal)
(e) Leveling Bolt (Gun-Metal with inserted Platinum Nail)

FIG. 9, COPENHAGEN, DENMARK

FIG. 7 TO 9. TYPES OF CITY BENCH MARKS

PRACTICE IN CITY SURVEY MONUMENTS AND BENCHMARKS

Practice in City Survey Monuments and Benchmarks

Some time ago an attempt was made to determine what and how many cities in the United States were properly surveyed; and how the work was done. The chief result of this investigation was to show a deplorable lack of systematic city surveys, and an immense variety of methods, monuments, and the method of placing them in the street, etc.

Few Cities Are Monumented

The cities of Washington, Philadelphia, Providence, Baltimore, St. Louis, Syracuse, Rochester, Portland, Me., Cincinnati, Galveston, Holyoke, and a few smaller cities have really complete topographic surveys based on triangulation nets, but the great majority of cities have absolutely no systematic survey and have constant difficulty in reproducing their street lines.

One case, and not so extreme either, is that of a far Western city, whose engineer wrote as follows:

> The condition of the street monuments in this town is something horrible. With one or two short intervals the ex-city engineer has been in office for the past 15 years, and he has used anything from a 4d nail to an unmarked rock, and has tried to keep their locations in his head. When I want to locate a property line I have to prospect over an area of three or four blocks to find a monument. As to benchmarks, no three benchmarks agree.

Types of Monument

The kind of monument varies from iron rods and pipes driven into the ground to stone or concrete posts set in concrete with copper bolts for points and with the heads inclosed in covered iron boxes. Naturally, stone posts are the most common, and appear to be the most satisfactory, although concrete, plain or reinforced, is almost equally popular. A few typical monuments and benchmarks are shown in the accompanying illustrations.

Fig. 1 shows the two types of monument used in San Francisco. The monuments are placed on 10- and 15-ft. offsets from the center line of the street.

Fig. 2 is the standard monument of Wilmington, Del., which is placed on 5-ft. offsets from property lines, two at each street intersection, diagonally opposite each other. This city has practically all its streets so monumented.

Fig. 3 is the standard monument of El Paso, Tex. This monument is in the pavement, offset 10 ft. north and east of the center of the street crossing. These monuments cost $17 each.

Fig. 4 is the standard monument for paved streets of Tacoma, Wash., placed in the street centers. In unpaved streets stone posts marked with an × on the head are placed with the top 18 in. below the surface.

Fig. 5 is the standard monument of Oakland, Calif. These are placed on offsets from the center line.

The last named three cities are typical examples of the many which use a monument in or near the street center. In other cities the monument is either on the property line or on a 2- 4- or 5-ft. offset from the property line, which ordinarily brings the monument in the sidewalk. A 5-ft. offset is apparently the most popular.

Fig. 6 is the standard monument of Hartford, Conn., where a heavy clay soil has made a deep, well anchored monument essential The tendency is for any ordinary type of monument to work up out of the ground, due to frost action on the saturated clay. Practically all the sidewalks are flagstones, and their movement by frost requires that the head of the monument be under the flagstones; generally a square hole is cut over the monument and a light cast-iron cover used. The letters H C M S on the top casting stand for Hartford City Mere Stone—a curious term, which seems to have survived locally from colonial times. These monuments cost about $2 each.

Types of Benchmark

In most instances the raised center types of monuments also serve for benchmarks. Other cities have special types for benchmarks. Fig. 7 shows the standard benchmark of the Sewerage and Water Board of New Orleans. Fig. 8 shows the standard benchmark of the city of Chicago.

Types of plug benchmarks for use on buildings and other permanent structures are shown in Fig. 9. These are used in Copenhagen, Denmark, where a precise-level net was made in 1907 and 1908.

Few American cities have precise-level nets, with the exception of those noted as having topographical surveys, even where the streets are fairly well monumented. The practice of using fire hydrants for benchmarks is very prevalent. In most cities no regular system of benches has been established and those benchmarks that exist are the result of previous construction work. In very few cities is any systematic method of regularly checking benchmarks in vogue.

Very few inland cities have datum planes based upon mean tide-water level, or standard datum. There are many instances of mere assumed datums of 100. For this there is little excuse because the Coast and Geodetic Survey level net and the net of the Geological Survey are now within reach of almost every city.

Monument Records

Not a few cities, like the one already referred to, have absolutely no record of monuments and benchmarks. This is due to a variety of reasons, some because all the survey work has been done by private surveyors, because the records have been lost or destroyed by fire, because the office of city engineer is so precarious that there is no inducement to build up adequate records, or for a variety of other equally good reasons. A great many cities have no other record than the original field notes and plats.

The best practice is to have every monument location referenced, recorded, described and properly indexed in a monument book, or on index cards; in some cases both are used. Small-size standard plats with monuments shown and described answer fairly well and are much used, both for original records and in connection with monument books and index cards.

The most frequent difficulty in reproducing street lines is lack of records. Loss of monuments and inaccurate original survey work also cause many a city engineer untold trouble.

Conclusions

Preference in kind of monument varies greatly. In Baltimore copper wires in the concrete sidewalks give the best satisfaction. Stone or concrete monuments generally are preferred, and iron and steel pipe are generally condemned as the worst, although they are favored by a few engineers, one for the unique reason that in spite of changes in grade and the burying of the mark, it can be easily located by a small compass or dipping needle!

Metal plates in sidewalks seem to be good practice, but marks on curbs are generally condemned as very poor practice.

The number of monuments or marks varies from one at the street-center intersection to two at each corner, one offset in each street. From the great number of the smaller cities which use street-center monuments, this would seem to be good practice, in spite of the danger of molestation from street construction work, and the necessity of opening the street surface to find the monument, unless some expensive type of boxed monument is used. Many complaints of disturbance of such monuments, however, were received.

Half-Circle Corrugated Culverts for Street Drainage

By John C. Hiteshew*

One of the most annoying problems of the average small city without proper storm sewers is taking care of the surface water at street intersections.

In Carlisle, Penn., at present practically all culverts across intersections are constructed of iron plates, ¾ in. thick, laid on old flagstone curbs, forming a conduit without a smooth flow line, having nothing more than a dirt floor (see Fig. 1). The plates are continually broken by traffic, entailing a repair cost of $2.50 per plate. The first cost of the plate culverts on a 60-ft. street is approximately $200.

The new corrugated culvert shown in detail in Fig. 3, is made of half-circle sections of corrugated culvert pipe with a bottom of bricks laid flat. The bricks were second-hand, having been previously used for brick gutters on streets that have been paved.

The ditch was excavated roughly to grade, and limestone screenings spread to proper grade, a brick gutter was then laid and rammed by hand hammer (using a 2x10-in. plank on the bricks), and then grouted with cement and sand, mixed 1 : 1½. The half-circle was then placed and overlapped. Large stones were then laid between the culvert and the side of the ditch, so that there could be no spreading of the culvert pipe. These were well rammed, and a layer of macadam was then placed over the large stone for a depth of about 6 in., and well rammed, then concreted to the surface of the street.

*City Engineer, Carlisle, Penn.

Had there been sufficient covering over the culvert, concrete would not have been used, but as we only had about 3 in. of top covering, the crushed stone would have been kicked loose by horses' hoofs, and would continually require patching. Light reinforcing wire was also placed in the concrete over the culvert to bond the thin concrete on top to the heavier mass on either side.

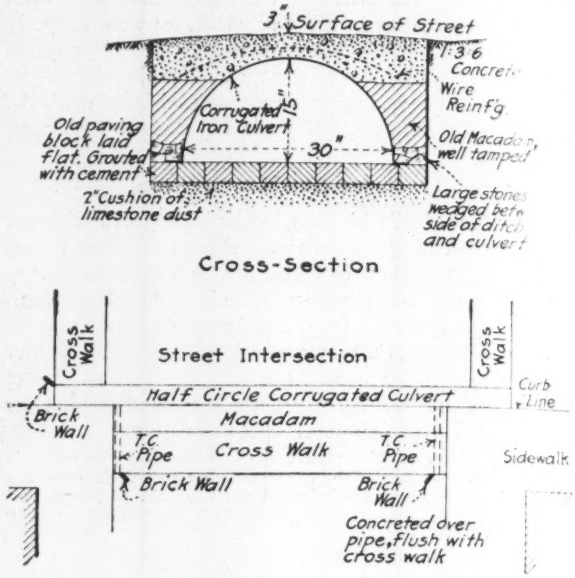


Fig. 3. Details of Half-Circle Corrugated Culverts, Carlisle, Penn.

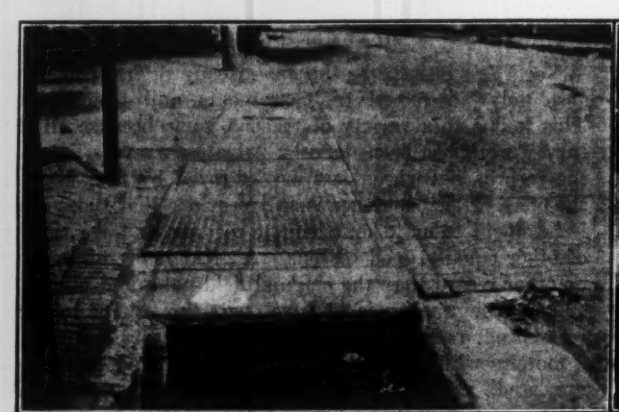


Fig. 1. Old-Style Cast-Iron Plate Culvert

Fig. 2. New Half-Circle Corrugated Culvert

Not only is a much neater and satisfactory job obtained, but the cost is less than half that of the old-style culverts.

Recent Cast-Iron Bridge Decorations

Two recent interesting examples of decorative treatment of girder bridges in a city can be seen in Cleveland, Ohio. The Pennsylvania Co., at a new bridge crossing at Euclid Ave. and 55th St., Fig. 1, has incased the steel columns supporting the girders in an ornamental cast-iron housing. There are a few other decorative details about this bridge, as for instance a cast-iron coping

FIG. 1. CAST-IRON ORNAMENTAL CASING OF STEEL BRIDGE COLUMNS, EUCLID AVE. CROSSING, CLEVELAND, PENNSYLVANIA CO.

on the top flanges of the girders. The bridge is painted a concrete gray.

The Lake Ave. bridge, on the Lake Shore & Michigan Southern Ry. at the entrance of Edgewater Park, is a far more elaborate attempt at cast-iron incasement. Fig. 2 shows this. The original proposal was that the whole soffit of the structure should also be incased, but the objections to this course were substantial enough to bring about the simplified proposal which was carried into execution. A remarkable feature of this work is its enormous cost, amounting to about $10,000, which, while made upon the requirement of the city, had to be paid 65% by the railway company and 35% by the city. Undoubtedly the similarity of the result to painted stonework in appearance will prove pleasing to a large number of people who see the bridge.

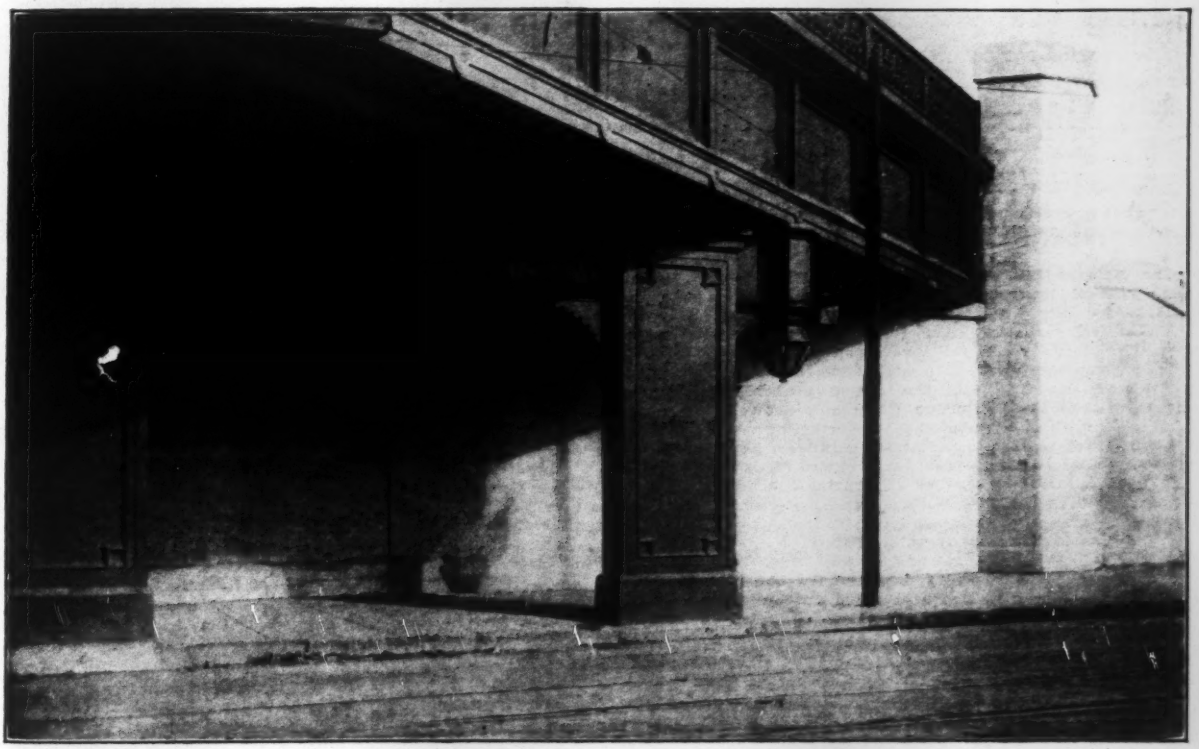


FIG. 2. LAKE AVE. BRIDGE OF L. S. & M. S. RY., CLEVELAND; FULL CAST-IRON INCASEMENT

NEWS NOTES

Sweating of Hydraulic Machinery is prevented in the power plant of the East Jersey Water Co., Paterson, N. J., by coating iron surfaces with an insulation composed of litharge and cork chips. The turbines, etc., so protected are first cleaned with a wire brush, then given two coats of red lead, after which a heavy coat of litharge is applied and cork chips are added as much as will stick; then a second coat of litharge is applied and a second coating of cork chips is dusted on. Two coats of paint and cork have sufficed in most cases. The insulating covering seems to act in two ways; first, by reducing the absorption of heat and the consequent deposition of moisture on the machinery surfaces, and, secondly, by the absorption of what little moisture is formed in the pores of the cork particles.

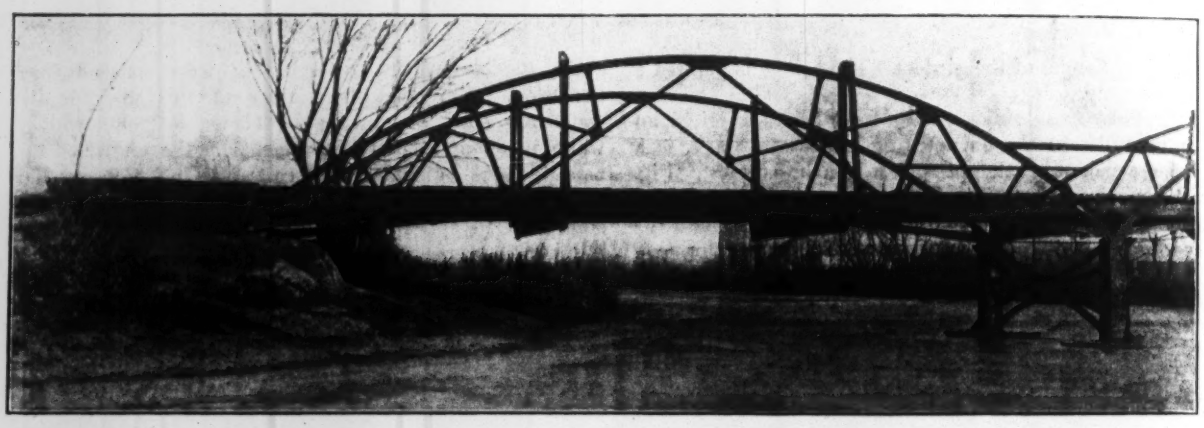
Bridge Built of Structural Scrap—A very unusual kind of bridge is shown in the picture. Scrap material was used in building it. This shows most clearly in the braces of the sway brackets, which show the punching of plate-girder stiffeners. The shape of the floorbeams also illustrates the improvised nature of the structure. The piers and their lateral bracing are perhaps the most typical items. Each pier post consists of a pair of channels, sunk or driven into the ground, and the two posts are connected by curved pieces of old railway rail. The use of scrap extended even to the abutment walls: A plate forms the lateral boundary of the road embankment along the approach or abutment, and other plates act as revetments in place of front wall and wing walls of the abutment. This noteworthy structure is at Van Loon, Ind.

Recent Improvements in Pavement Details, New York City—The old 6-ft. radius corner curb has been abandoned in favor of one of longer radius, allowing traffic to pass easily from one street into another. Storm-water inlets have been removed from the corner and placed opposite the building line, thus eliminating deep corner catchbasins and flowing streams of water over the crosswalk. It is proposed in the future to place more frequent storm inlets in order to reduce the maximum height of curb. The best quality stone-block pavement has been adopted as standard for street-railway tracks, and the policy has been inaugurated of making all street-railway repairs under this specification without waiting until entire reconstruction of the pavement in the track is required.—H. W. Durham, Chief Engineer, Bureau of Highways, Borough of Manhattan, New York City.

City Engineers as Regulators of Fences—Among the numerous new resolutions and rules adopted by the Board of Directors of the Street and Sewer Department of the City of Wilmington, Del., is the following:

Sec. 1. That the Chief Engineer and Surveyor and the Assistant Engineers and Surveyors of the Department of Engineering and Surveying of the City of Wilmington, Del., are hereby authorized to act as the City Surveyors and Regulators for the regulation of partition fences as provided by the charter of the city, and are further authorized to provide regulations for partition fences in the city, in conformity with the terms and provisions of this resolution and in conformity with the terms and provisions of the city charter and the revised code.

Sec. 2. That a good fence of wood, iron rods, wire, stone, brick or portland cement concrete 4 ft. high, or an iron fence of ornamental design 3 ft. high, shall be deemed a lawful partition fence within the limits of the city. Barbed wire or hedge shall not be used for partition fences except by the mutual consent of the owners of the properties divided by such fences.



ROAD BRIDGE AT VAN LOON, IND., BUILT OF SCRAP STRUCTURAL STEEL

The Maintenance of a Plain Gravel Road under Heavy Traffic cost $150 per month for about ¼ mile, or at the rate of $5400 per mile per year. The road is between Lafayette and West Lafayette, Ind. Due to a bridge washout it carried the traffic of two roads for several months. This traffic included a passenger automobile service to replace a trolley-car service made inoperative by the loss of the bridge. A traffic census by students at Purdue University showed 23,979 vehicles a week, three-fifths of the number being motor vehicles. The density of traffic was sometimes as high as 400 vehicles per hour. The roadway was 20 ft. wide. The surface was kept constantly wet by the use of a sprinkling wagon. Every few days it was dragged with a one-way drag. Holes and depressions were filled without delay. With this constant care the road was kept in excellent condition. No bituminous or other surfacing or binding material was used. One man and a team were kept busy every day, and frequently extra help was needed.—George E. Martin, Purdue University, in a paper before the Indiana Engineering Society.

A Payroll Chart being got up by the S. C. Carpenter Drafting & Engineering Co., 26 Baltimore St., Hartford, Conn., gives the pay for rates from 10c. to $1.54 per hr. (varying by 2 and 2½c.), for different numbers of hours and quarter-hours. It also gives the hours and minutes from a given time in to a given time out, up to overtime extending to 10 p.m. This chart, 6 in. square, will be sold at $1 (50c. for orders received before Mar. 1, for delivery after that date).

Dredging 100 ft. Deep with a Suction Dredge is an interesting feature of the re-working of old tailings of the Michigan stamp mills of the Calumet & Hecla Copper Co. The tailings were disposed of by dumping them into Torch Lake. For recovering them a special dredge with screening plant has been built by the Bucyrus Co., of South Milwaukee, Wis. The hull is of steel 110x56 ft., and has a two-story superstructure with the revolving screens on the upper floor. The ladder is 136 ft. long, supported by tackle from a long braced boom. One 20-in. electrically operated pump serves the suction pipe and delivers the material to the screens, while another similar pump forces the screened material through the shore delivery pipe.

Handling Dump-Cars with Derricks in open-pit coal mines is one feature of the work of the Central Coal & Coke Co.'s plant near Pittsburg, Kan. While the steam shovels are excavating or stripping on one side of the cut, which is 30 ft. deep, coal is being mined on the other side. The coal is loaded into 2-ton tram cars, which are hoisted either by a stiff-leg derrick or a revolving derrick, each traveling on a short broad-gage track. The former has a 50-ft. boom and the latter a 60-ft. boom. The cars are taken from and replaced upon a track laid along the top of the cut. The same general method might be employed in many cases in handling cars or wagons at excavations for foundations or other purposes.

The Motor Snowplow for Streets described on p. 171 of our issue of Jan. 28 may have an adjustable wing or extension 8 ft. long attached on one side of the machine to spread the snow displaced by the main plow. The tractor may be used also to haul a sweeper.

Editorials

A Quantity-Surveyor Ordinance

That quantity surveying is a practice which will well bear importation into this country is pretty generally admitted by all of those who have studied its workings; the difficulty lies in the method of establishing the practice here. On another page we reprint a recent ordinance of the city of St. Louis, whereby the appointment of "certain persons as Quantity Surveyors" is provided for, and a start on the quantity-surveying system is made. Such a start must necessarily be slow, for the movement is radical, and the progress of the system will be watched closely by engineers and architects in other localities.

In the question of the surveyor's responsibility, the St. Louis ordinance departs very radically from the English system. The following quotation from a British law book will show that in that country the accuracy of the surveyor's report is guaranteed only by his professional integrity:

> The builder or contractor who desires to avoid the loss which may be occasioned by errors on the part of a quantity surveyor should be careful to have the quantities made a part of his contract; for it has been decided that a quantity surveyor is not liable to the accepted builder, either by contract or representation, for errors in quantities.

We think that it might prove a hard job to find anyone in St. Louis willing to accept an appointment as Quantity Surveyor under the bond clause in the ordinance.

Instructions for First-Aid

The very concise and useful first-aid instructions drawn up by the Conference Board on Safety in Sanitation have been reprinted elsewhere in this issue. Some little condensation and elimination of a few minor paragraphs have been necessary to secure a single-page arrangement most useful to engineers and contractors in the field. The instructions are in line with the latest medical practice and have the strong backing of the National Founders, National Manufacturers, National Metal Trades, and National Electric Light Associations. It is useful to note here also the contents of the first-aid kit which the Conference recommends. For apparatus, there would be a tourniquet, nickel-plated scissors, nickel-plated tweezers, a triangular sling, a wire-gauze splint, some safety pins, a teaspoon, a metal cup, a medicine glass, two medicine droppers, some paper cups and some accident record cards. As medicaments, there would be small bottles of castor oil, 3% alcoholic iodine, white-wine vinegar, 4% boric-acid solution, aromatic spirits of ammonia, jamaica ginger, and a few tubes of burn ointment (3% bicarbonate of soda in petrolatum). There would also be a large square of flannel, a pound roll of absorbent cotton, some 10-yd. rolls of gauze bandage in 1-, 2- and 3-in. widths, a few yards of 1-in. adhesive tape and a half dozen strips (sterile packages) of gauze. The Conference is supplying such an outfit at cost.

A City Geologic Map

A geologic map of New York City is in process of development and is a work which other cities might profitably undertake. For many years past the City of New York has made extensive borings to determine the character of the underlying material in connection with projects for many of its public works, such as the great East River bridges, the rapid-transit subways, the Catskill Aqueduct tunnel, and the foundations of important public buildings. A good many thousand dollars have been expended in these subterranean investigations; and in each case the information obtained and the samples of material brought up by the borings have been preserved by the particular department or board or commission which had the work in charge.

There was, however, no organized coöperation between these different organizations; and any one desiring information as to the subterranean conditions at a certain place might hunt through several departments before he found what he desired. The Society of Municipal Engineers of New York some time ago urged that all these borings should be gone over, classified and used for the preparation of geologic maps. This suggestion was placed before the Board of Estimate and Apportionment, which recently appropriated $5000 to put the plan into execution. The Museum of Natural History, which is largely supported by the city, offered to provide space for the accommodation of the samples of borings and of the charts made therefrom. Dr. Chas. P. Berkey, of Columbia University, was retained as consulting geologist to supervise the collection of the samples and their arrangement in such a manner as to make them accessible to anyone desiring information.

It is true, of course, that in few cities have subterranean conditions been as thoroughly explored as in New York City; but by combining both public and private work, it would be possible in most cities to make a very useful geologic map and add to it from time to time as information accumulated. Besides the information obtained in excavating for deep foundations, wells are continually being dug or bored in various parts of most cities; and by coöperation in preserving permanent records of the strata pierced in such well construction over a period of years, the data for a very fair geologic map could be secured at practically no cost. The value of such information to any city in the construction of sewers and laying water mains, electric conduits, etc., would well justify the small expense involved in collecting and recording such data.

Better Cooperation Between Engineers and Contractors

The unfairness of one-sided engineering contracts which clothe the engineer "with a mantle of infallibility," cast a variety of unestimatable burdens on the contractor, and increase the cost of engineering work, has frequently

been discussed in these columns. Therefore it is gratifying to note that such protests against an undesirable tendency have not been without effect and that a healthy reaction is evident. Tangible evidence of increasing mutual appreciation between contractors and engineers is seen in the discussion at the recent annual meeting of the Canadian Society of Civil Engineers (briefly reported in ENGINEERING NEWS, Feb. 4) of a committee report on general clauses for contracts and specifications.

Certain clauses covering, for instance, engineers' duties, contractors' responsibilities, certificates and payments, official plans and drawings, claims for extra work, defaults, carrying on the work, etc., were collected from the practice of a number of successful Canadian engineers and presented as a guide for the members of the Society. The report was received with many expressions of appreciation as a constructive document; at the same time there was free and frank criticism of some clauses which bore down hard on the long-suffering contractor. For instance, he was made responsible for not detecting the engineer's mistakes; he had to rely on the engineer's opinions as final judgments; he received no compensation for long delays due to the engineer or the purchaser; he had even to let the engineer change his contract price!

In defense of such requirements the committee mentioned the successful careers of the engineers who had used one or more of these several criticized clauses and noted the large works economically and harmoniously built under such provisions. The character of the average present-day contractor as an intelligent and upright individual was vindicated by his engineer friends, and the assembly was not slow to recognize that the coöperation of contractors in the cited cases was due to the recognized personal fairness of the engineers and their incapability of using an unrecognized destructive weapon. Moreover, probably none of the successful contracts mentioned contained all the possibly burdensome clauses, a condition which might soon arise if the committee report had been accepted in its entirety as a guide. The committee in question was asked to revise its report in the light of the discussion. This recognition of the value of promoting coöperation with dependable contractors perhaps is but the dawn of a better day.

Wind Stresses and Empirical Methods of Design

In commenting in our last issue on practice and book teachings concerning wind effects on mill-buildings, we pointed out that it is necessary to rely on empirical methods in proportioning mill-buildings to resist wind. But though this necessity be obvious, yet the use of empirical methods in structural design remains unpalatable: the engineer whose chief training has been in rational analysis of structures dislikes to accept a frankly artificial set of assumptions. We therefore advise a careful reading of the article on railway-bridge wind stresses published in the present issue, as well as a further article on highway-bridge wind stresses, the last of the series, which will follow shortly.

The whole history of wind calculations for bridges is the evolution of empirical method. This means that experiment never succeeded in giving unexceptionable figures for wind pressure per square foot in maximum storms, or telling how the pressure acts on the extremely irregular surfaces of a bridge, or indicating whether upward and downward wind forces may occur, and how the pressures are distributed over the whole length of a bridge, under the worst conditions. All these things, and some more, must be known before a wind-stress calculation can be made that is entitled to be called rational, and so long as they are not known we can only design empirically; that is, we must guess.

But this guessing is not blind. It is guided in its development by the constant test of experience, no less than by partial checking with the results of whatever experiments are made. Besides, common observation may sometimes furnish as accurate information as could be deduced from a very extensive set of experiments and may lead to principles of design which represent reliably the reasonable probabilities of meteorological events and structural behavior.

Thus, in many long-span bridges we know that with regard to lateral forces the structure is flexible, being shallow, and that it will therefore have a rather long period of natural vibration. We also know—partly from autographic wind-pressure records and partly through ordinary observation—that wind gusts in certain weathers tend to occur at intervals fairly comparable with these long vibration-periods. These conditions may be recognized as giving opportunity for distinct resonance sway, if the bridge chords are stressed at all severely by the wind. Well-designed bridges proportioned for modern wind specifications do not, however, show such sway or oscillation, even in the gustiest storms, although it should be easily noticed if it occurred. The conclusion is, with satisfactory degree of certainty, that our bridges are not in danger from wind effects, at least in the chords—and the lateral webs and their connections are known to be safe because the assumed pressure is enough to allow for the worst *local* wind effect.

Taking this conclusion in connection with one other—that bridge laterals are not grossly excessive, since traffic-vibration is perceptible in almost any bridge under its maximum loading—we can set it down as safely established that present practice in wind specifications is not far from right. Though this is a perfectly empirical conclusion, it is obviously in close touch with the physical facts and so is entitled to great respect from even the most "rational" engineer.

Economics of Machine Manufacture

Henry Ford, the automobile manufacturer, testified before the United States Industrial Commission on Jan. 22 that his company is now earning *profits* of $25,000,000 to $28,000,000 per annum. One can only grasp the significance of these huge figures by comparison. The Pennsylvania R.R. Co., which is by far the largest railway corporation in the United States, or for that matter in the world, paid in dividends to its stockholders in the year ending June 30, 1914, $29,770,865. The Union Pacific last year paid in dividends a little less than $24,000,000. No other railway company in the United States paid dividends last year anywhere near the phenomenal profits of the Ford company. The New York Central paid a little over $11,000,000; the Baltimore & Ohio paid a little

less than $7,000,000; the New York, New Haven & Hartford paid about $2,300,000; the Southern Pacific Co., $2,700,000; the Chicago & Northwestern, $10,900,000; the Norfolk & Western, $900,000.

Returning again to the Pennsylvania R.R. Co., that great corporation, which is generally agreed to have had efficient and honest management, owns property representing a total investment, according to the Interstate Commerce Commission's official statistics, of about $927,000,000. The Ford company is capitalized at $2,000,000 and probably its entire plant and equipment could be duplicated for much less than its annual profits. The $29,000,000 of dividends paid by the Pennsylvania R.R. Co. were distributed among something like 100,000 stockholders, scattered all over the world. The profits of the Ford company were divided among the eight persons who own the entire capital stock.

Those who believe the government ought to own the railways in order that the public may secure the profits which are now paid to holders of railway stocks, might well reflect whether it would not be a better proposition for the government to buy up Mr. Ford's business at an appraised valuation instead of buying the Pennsylvania R.R. It would cost not more than a fortieth or fiftieth as much and yields nearly as much profit. Possibly there may be doubt whether under government management the Ford business would earn its $25,000,000 profits per annum; but may there not also be doubt as to the efficient operation of the Pennsylvania R.R. under government ownership?

Questions of economics aside, it is of interest to engineers to study the reasons for the enormous profits earned by the Ford company. There are, of course, many minor causes which had to do with the final results; but speaking broadly the main reason why the company has been able within the last three or four years to earn profits almost or quite without precedent in the manufacturing industry, is because it has been foremost in this particular field in the production of an enormous number of machines all exactly alike.

It is often said that large-scale production is a necessity for economic production; but the history of a number of important manufacturing concerns during the past dozen years conclusively shows that large-scale production may yield very small profits or none at all. In machine manufacturing especially, the developments of the past dozen years have shown that a concern making a large variety of special machines, many of them built to order, must charge a very high price for such machines in order to cover the actual cost of their production; whereas on the other hand, a concern which can build a thousand, or ten thousand, or a hundred thousand machines all exactly alike and develop a permanent business in their production and sale, can reduce the cost per pound of the completed article over the price of the raw material to an amazingly low figure.

Curiously enough, it is said that Mr. Ford himself was not responsible for the policy which has brought about his company's transcendent success. The story is that years ago, when it was the practice of automobile manufacturers to build machines of a variety of styles in order to attract customers of different tastes, Mr. Ford went to his financial backer with a request for funds to manufacture cars for the coming season's business. The financier asked how much he required, and Mr. Ford replied that in order to produce the variety of cars that he deemed essential for the development of his business he would need a certain large sum. The financier flatly refused and said, "I will give you money enough to build one style of car, but I won't invest any more. You will have to do the best you can with that."

Mr. Ford made a virtue of necessity, and by an active selling campaign secured a profitable season's business while building one type of car, and thereafter followed that policy with the amazing results now known to all the world.

It is, of course, nothing new that very great reductions in manufacturing cost are possible by large-scale production and repetition processes carried on by machinery. It is only within very recent years, however, that automatic machine tools for metal working have been developed and perfected to such an extent, in connection with the use of high-speed cutting tools and high-quality alloy steels, that it has become possible to produce at an amazingly low cost for manufacture not merely articles of hardware or such mechanisms as clocks, watches, firearms and typewriters, or such rough productions as agricultural machines, but also such highly developed and elaborate productions of mechanical and electrical engineering as the modern automobile.

Letters to the Editor

Lugs or Spacers to Prevent Expansion Failures in Wood-Block Pavements

Sir—The failure of the wood-block floor of the reinforced-concrete Dallas-Oak Cliff Viaduct at Dallas, Tex., described in your issue of Jan. 14, 1915, p. 92, is but another instance of the necessity for an adequate factor of safety to counteract the possibility of destructive expansion in creosoted wood-block pavements.

It has been repeatedly demonstrated that, regardless of the width of a street, an inch, or at most, an inch and a half expansion joint parallel to the curbing, is insufficient to successfully resist expansion emergencies. This is especially true of such pavements laid in the South where long periods of dry and excessive heat are followed by heavy rainfalls.

There is only one possible and practical way to multiply the factor of safety for wood-block pavements laid under all climatic conditions; that is, to provide for individual expansion joints or spaces between each block. It is impractical to accomplish this by depending upon the

eye of the paver for uniform spacing, and therefore must be secured in another way; either by nailing strips or separators upon individual blocks, or by providing that lug blocks should be used with the lug an integral part of the block and extending its full depth. These ribs or lugs should be placed in the center of one end of each block; should be wedge shaped or pointed and should extend the full depth of the blocks. As the blocks expand, these ribs or lugs will be gradually compressed.

The usual inch or inch and a half expansion joint along the curbing may be used in combination with the lugs, or collapsible spacers.

An ordinary rectangular-block bridge floor is generally laid with the blocks in slight contact so that hot pitch squeegeed over the surface has but little opportunity to run down between the blocks and fill the interstices, consequently when the blocks shrink there is but very little pitch present to mix with any grit or dust which will necessarily fill the interstices as they widen. As the blocks swell and take up this shrinkage, the grit and dust are not compressible and prevent the assumption of the normal condition initially occupied; therefore the force exerted by the blocks in an effort to reach their initial position at times reaches tremendous proportions.

If spacers, ribs or lugs are used to separate the blocks on a bridge floor plenty of pitch is allowed to fill the interstices, then as the blocks shrink and the spaces widen any foreign material finding its way into these shrinkage spaces only unites with the pitch to make a compressible mastic.

Assuming that the maximum shrinkage between the green and oven-dry condition of long-leaf yellow pine untreated wood blocks is but 6%, then a 41-ft. street, the width of the Dallas-Oak Cliff Viaduct, could expand to an absolute maximum of 29½ in. Ordinarily the specifications would call for a 1-in. expansion joint along the curbs to take care of possible expansion. The resultant 2 in. represents but 0.67% of the total possible expansion.

The Dallas-Oak Cliff Viaduct floor expanded 8 in., or 1.6% of the total possible expansion. If blocks had been used with spacers or lugs to provide an individual expansion joint of ¼ in. for each block in this 41-ft. width there would have been seventy 7-in. blocks, or 17½ in. of compressible spacing to be taken up before the point of destructive expansion could have possibly been reached; and if as an additional factor of safety a 1-in. expansion joint had been left along each curb there would have been a total of 19½ in., or an aggregate spacing equivalent to 66% of the total possible expansion. Of course expansion of creosoted blocks is retarded to some extent by the creosote oil, but destructive expansion continues to occur with startling frequency, and hence, the comparison is based upon untreated wood.

The Jennison-Wright Co.
By Frank W. Cherrington,
Chief Engineer.

Toledo, Ohio, Jan. 26, 1915.

Competition by Professors in Engineering Schools

Sir: A question has recently come up for discussion in our local engineering society relating to a question of professional ethics which may be of wider interest than this immediate locality. The question is whether it is consistent with sound professional ethics for the professors of engineering in our state university to engage in consulting engineering work in addition to their regular duties in the university for which they receive a salary from the state.

I am aware that this is done, to greater or less extent, in many of the engineering schools throughout the country, but it is none the less a fair subject for discussion. Suppose, however, for the sake of argument, that these professors may properly engage in such private practice. Are they justified in making use, in such private work for which they receive payment, of the laboratory and other facilities of the university which the state pays for; and is it proper for them to make their reports upon the official stationery of the university, thereby giving prestige to their reports as if the state or the university were responsible therefor, which is in effect deceiving the public?

Further than this, assuming again that professors may engage in such work without being false to their obligations to the state which employs them and to their students, is it fair competition for them to undertake such work at a price far below that which the private consulting engineer, who has to rely upon his practice for his living, can afford to work for?

Admittedly, the professor can afford to name a lower price because he has his regular salary from the university to rely upon and is at no expense for equipping and maintaining a laboratory, since he makes use of the facilities furnished by the university. Office rent, and the hire of stenographers, clerks, etc., which the private engineer has to bear, involve no expense to the professor of engineering; and there are cases where he has utilized students to aid him in his professional work, paying them a nominal compensation or none at all.

If there were indeed a vast amount of engineering work to be done and plenty of opportunities for the experienced and competent engineer in private practice to keep himself occupied at remunerative figures, as one might suppose from the literature sent out by some of the engineering schools,—if such conditions as these really prevailed, there might be little fault to find with the professor spending his time in private engineering practice, provided he can do this without interfering with his college work. But everybody, or at least every engineer who is working to earn his living, knows that this is very far from being the case. In the engineering field today it is practically a case of the survival of the fittest, or rather, let us say, of the man who can do the work at the lowest figure. Good men are all the time being crowded out of the profession and taking up some line of business or farming or whatever opportunity will offer them a living. If the standard of engineering fees is to be cut down to what the man can afford to accept who is on a salary anyway and does this class of work merely as a side line, the standard of engineering work will inevitably be degraded to the detriment of the public as well as the profession.

I want to suggest, further, the question whether the service given their clients by these teachers who do engineering work on the side is really good service? There are, of course, certain engineers of national reputation holding chairs in our colleges whose standing in the profession is so high that no one will question the thoroughness with which they perform any work they under-

take. But I raise the question concerning the average professor on the average outside job. In my opinion he can seldom devote the thorough time and study that ought to be given to an engineering work if it is to be done in the best manner; further, I question whether the average professor keeps sufficiently up to date and in touch with practical experience to give the best results to his client. I will not take your space to cite concrete examples illustrating this and other statements made above, but I do wish to call the attention of the profession to one more aspect of the question that seems to me the most vitally important of all.

We all agree that the maintenance of a high standard of ethical conduct by the engineering profession is absolutely necessary if it is to retain public confidence. Every thinking man agrees that the most important work of our educational system—the best thing a young man can obtain from a college course is the development of a high moral character. What influence does it have upon the young men in our colleges to see the men who are paid a salary to engage in the work of instruction taking part of their time to carry on private business, generally to the detriment of the student and the destruction of his ethical standards?

I am aware that many men of high character in our engineering schools do engage in outside work and doubtless feel fully justified in doing so under the terms of their agreement with the institution which they serve. It seems to me nevertheless that the practice is subject to abuses which in places have become serious and deserve the attention of the profession.

In this discussion of the subject, however, I wish particularly to refrain from personal reflection on any individual or any special institution. For that reason I have not mentioned any special locality in this letter and sign myself only,

"Consulting Engineer."

Jan. 25, 1915.

[Our correspondent raises a very old question as well as some new ones in the above letter. He has presented, admittedly, only one side of the case; and, without attempting to discuss the question at length, it is fair to point out that the trustees of many engineering schools believe that the interests of the students will be best served if those engaged in teaching them engineering are enabled to keep up to date and in touch with practice by devoting part of their time to private work as engineers.

In a large number of engineering schools it is clearly understood as part of the contract in engaging the services of a professor that he is at liberty to devote a certain part of his time to private consulting work. The compensation is fixed with the clear understanding that a higher grade of men can be secured under these conditions than would be possible were such outside work prohibited. Surely a man accepting service under such conditions may undertake private work with an entirely clear conscience.

It will probably be generally agreed, however, that professors who undertake engineering work under such conditions ought to observe the same general ethical principles that should govern any other engineers; and that in charging for such private work they will be doing injustice to their profession as well as to themselves if they charge smaller fees for the service than would be charged by an engineer devoting his time wholly to such work.

The engineering profession is suffering today because its members receive a compensation which is on the whole smaller than the responsibility and the importance of the work they perform deserves. Men at the head of the profession are as much to blame for this state of affairs as those on the bottom rungs of the ladder who are struggling for a foothold, and it is well that this situation should be clearly pointed out.—EDITOR.]

Engineers and Civil-Service Examinations in Philadelphia and Elsewhere

Sir—In ENGINEERING NEWS, of Nov. 5, appeared on p. 946 some observations on the merit system appearing in the report of Mr. M. L. Cooke, Director of Public Works in Philadelphia. I wish to discuss the question from the standpoint of the administrators of the merit system in the same city. The issues are not local at all, but wherever concrete illustrations are necessary, I shall use the Department of Public Works in Philadelphia in order to deal in facts at first hand.

Mr. Cooke, after first expressing his unqualified approval of the merit system generally, states that he is "convinced that the civil-service system in this country is suffering from an overconfidence in its methods by those administering it."

There have been, perhaps, as many changes in the methods of the merit system in the past few years as in any other line of governmental activity. Our confidence in the merit system is strong, but we are changing its methods year by year in the light of new experience, equipment and conditions. We used to examine pavers, rammers, carpenters, painters, blacksmiths, etc., by a written test, but we have long since discontinued that and now we examine them by actual trial on the streets and in the shops. In looking over some *old* examinations for draftsmen, I found the following questions: "Name the tools a draftsman uses," and "Define plane trigonometry." But now we take two days for a draftsman's examination. The first day is devoted to computations of an intensely practical kind; at the close of the day the applicant puts his results upon a separate sheet. The next day he brings all his instruments, his results are handed back to him, and he is required to make a finished drawing. We furnish boards, paper and tables. This is a section of the ordinary life of a draftsman taken as a standard for measuring his capabilities.

High-grade engineers were, perhaps, once examined by assembling them in classrooms and giving them written questions for answers; but now we seldom assemble the candidates at all and have even given them no written questions whatsoever. Not only that, but the *old* idea of examinations was to search a man, lock him up and put him under guard during the ordeal; but now we encourage him to use handbooks, tables, slide-rules, and the other usual equipment of his profession. These and many other facts indicate advances that have been made in the methods of the merit system within the past few years.

Mr. Cooke's next observation is that he believes "over a large part of the field the methods used are archaic;

that as the grade of the position to be filled rises, the present methods of examining are less and less likely to produce the right kind of man."

Perhaps the thoughts expressed in my preceding paragraph may enlighten the reader as to the fairness of the assertion that the methods are "archaic." But he specifies the higher-grade positions, so let us turn for a moment to tests for higher-grade positions.

There have been within the past two years examinations for at least four very high-grade positions in the Department of Public Works over which Mr. Cooke presides. The first was for Chief of the Bureau of City Property, salary $4300 per annum. Let me give the method of examination briefly: The announcement was widely distributed, containing Mr. Cooke's description of the duties of the place and the type of man he wanted. The Civil Service Commission selected a board of examiners, consisting of the president of a large bank and two managers of especially large estates involving several million dollars each. This board prepared a set of questions to elicit the training and experience of the applicants and prepared five problems in real-estate management. These questions on experience and five problems in real-estate management were distributed to all persons who might ask for them and applicants were given about a month in which to file their answers. The work was to be done at home and an affidavit submitted as to its originality. The applicants were never assembled. The board read such papers as were submitted and all those who received 70% on this part of the work were called before the board singly for an oral interview as to judgment, tact and personality; 40% was given to experience, 30% to problems in real-estate management, and 30% to the oral interview. Moreover, confidential letters of inquiry were addressed to former employers and references.

I think it may be fairly stated that an industrial establishment seldom goes into the question of selecting a manager so thoroughly and with so many safeguards as are shown in this type of examination. An industrial establishment seldom commands the services of three men of such standing in the community as the three men who conducted this test. Perhaps it is also fair to assume that Mr. Cooke approved the result of the test, for he promptly selected the first man on the eligible list to fill the job. The law gives him a choice among the first four. It may also be assumed that the person thus appointed has been successful, as indicated by his retention in the position.

The second important case was that of District Surveyor and Regulator, which position pays $4000 per annum. Again the examination was conducted as a nonassembled test and the *pièce de résistance* for the applicants was a topographical map of a proposed addition to a city. The applicant was given about a month to submit his plan of the addition, all necessary details as to location, surroundings, purposes, etc., being furnished him by the examiners. The result of the examination was again most happily sustained by Mr. Cooke's appointment of the first man on the eligible list.

The third important case was that of City Architect, which pays $4000 per annum. This examination was also of the nonassembled type. The Philadelphia Chapter of the American Institute of Architects was asked by the Commission to designate two of its members to act with the Chief Examiner as a board. The examination consisted of experience, 30%; executed work, 30%; oral interview, 40%. Under the subject of executed work, each applicant was required to submit photographs, drawings, plans and specifications of work that he had done. Mr. Cooke wrote, "We are confident that under the plans for holding this examination which you have developed, the result will be a list of only those who will, in a very large measure, meet the high standard set." Nineteen architects, many of them well known, competed. After the board had passed on the exhibits of executed work and read the statements of training and experience, those who seemed to possess qualifications were given oral examinations by the board. Again the merit system apparently discriminated properly between the competent and the incompetent, and Mr. Cooke filled the position by appointing one of two capable and well known architects who tied for first place.

The fourth important examination in Mr. Cooke's Department was that for Chief of the Bureau of Gas, at a salary of $5000 per annum. A board was constituted as above outlined and the examination was of exactly the same type. The position is one that requires not only an executive, but a man of the highest order of technical training and one whose proved interests lie in the service of the public rather than that of the corporations. Mr. Cooke's own statement of the duties and the qualifications was, of course, made the basis for the examination. The first man on the eligible list was appointed in this case also.

In a little more than a year past, nine different eligible lists for Engineers at salaries ranging from $1500 to $4000 per annum have been created by the merit system for the Department of Public Works, and in eight out of the nine cases, the Department has appointed the first man on the list, and in one case eight of the first nine have been selected. We should add here that the law in Pennsylvania permits the appointing officer to pass over three out of each seven names, and for a single appointment he has a choice of one out of the first four. It would thus appear that under the merit system as now administered it has not been necessary for the appointing officer to exercise that degree of discretion which the article under discussion would seem to indicate as necessary.

But the editor observes, "This applies especially to the higher positions . . . but applies also to the lower grades of city employment."

Let me illustrate one of the lower grades. The position of Highway Inspector pays from $82.50 per month to $1300 a year. In a little more than a year there have been made 98 appointments of Highway Inspectors. In so doing, the Chief of the Highway Bureau has passed by only 17 names on the eligible list. Under the law allowing him to pass three out of every seven, he could have passed 75 names and then either called upon the Commission for more names, or, in the absence of eligible lists, made appointments of his own selection as the law provides. Similar facts exist with reference to appointment from various other lists for the Department of Public Works. Of course, Mr. Cooke's observation above quoted might be interpreted to mean that some of the appointments he has made are not satisfactory, especially in the higher positions, but I assume this is not the case, since none of them have been dismissed or suspended.

Mr. Cooke's next proposition is that "the civil service should be looked upon as corresponding to an employment bureau in the ordinary industrial establishment."

Critics of the merit system often forget the fact that

there is a vast difference between filling a public position and filling a private position. Both should be filled according to merit, of course, but every citizen, high and low, has an inherent right in a public position whether there is a civil service law in existence or not. The civil service law merely guarantees him a chance to exercise that right. In an industrial establishment, however, the employment bureau may adopt any method whatsoever that pleases its fancy and may change it upon the whim of the moment or the necessities of an hour without regard to the rights of those who seek employment there. The head of such a bureau may reject an applicant for any reason whatsoever or for no expressed reason. The records of his investigation or his tests of fitness are not public records, and, in fact, he need preserve no records at all if he wishes. Thus it is by no means logical to compare the civil service department to an employment bureau in an industrial establishment. The thing that we do, on the other hand, is to adopt all the useful methods of the private corporation which may be applied to a public competition. We advertise most freely and we investigate by letter, by telephone, and by personal visit to the extent of our ability.

Mr. Cooke further suggests "that more weight should be given to a candidate's previous experience and record and less to what he is able to submit in a four-hour examination."

Let me observe here that those familiar with the operation of the merit system are painfully aware that some of the most notorious violations of the civil service law are accomplished by giving the large weight to training and experience, which is the only part of the usual examination in which the identity of the competitor can be seen. Moreover, statements of training and experience, even though verified, do not constitute so safe a criterion for rating applicants as to warrant giving it an unusual weight. One man may hold a position twenty years and not gain nearly so much real experience as another man who may hold the same position for five years. Indeed, some of the best administrators we have had and now have in public life never held an administrative position or one similar to it before.

My experience as an examiner has convinced me that there are few subjects so hard to rate fairly as an applicant's "training and experience." We believe it should have a reasonable weight, but we do not believe in going to extremes. In the important examinations outlined above, only 20 to 40% was given for the technical part of the test. If Mr. Cooke's suggestions were adopted, we should have to cut down further the weight of either the oral examination or the technical test.

The verification of statements of training and experience is exceptionally difficult, one reason being that it is very seldom that an adverse statement can be secured from a former employer or a reference, even with assurances of confidence, and the magnitude of the task can be imagined when even a local commission has several thousand applicants annually. We usually give 30 to 40% to training and experience, but whenever necessary, we also give 20 to 30% to an oral interview upon personal fitness. Thus we are allowing 60 to 70% for record and personality.

Passing from this, we find next a suggestion that "promotions should in greater measure be dependent on record of work done rather than on examination."

I think this is true, but up to date no satisfactory method of recording work done by employees, so that it can be used to determine promotions, has been worked out either in Philadelphia or elsewhere, though many claims have been made. Mr. Cooke is evidently not arguing for promotions based on the opinion of the appointing officer. No one would in this day seriously contend that this would be the correct procedure. He suggests a "record of the work done." Manifestly, this record must be one that could be inspected by the appointing officer in his various bureaus, and, surely, by the employees who are affected by it.

It is much easier to suggest a step of this kind than it is to provide the vehicle for carrying it out. I should be most happy to have anyone solve the problem of keeping these records so that promotions may be made therefrom by some established rule. Fairness and *esprit de corps,* of course, require that employees win promotions by competition. But whether that competition is upon "record of work done" or upon an examination depends absolutely upon the invention of an open and above-board system of recording work done.

The next suggestion offered is that "civil service should be operated primarily to promote efficiency rather than to check favoritism."

These two propositions are Siamese twins. You can't promote efficiency without checking favoritism and you can't check favoritism without promoting efficiency.

We now come to his final suggestion that "methods should be adopted to obtain quicker results from examinations."

In this connection, Mr. Cooke observes that most desirable candidates will not wait around "two months" after an examination to find out whether they are to be available for appointment. When I first read this statement in Mr. Cooke's departmental report some time ago, I was somewhat concerned. I thereupon took every eligible list that had been created for the Department of Public Works for the fourteen months preceding. I collected the number of days that elapsed between the examination and the announcement of the result. Fortunately, I found that the actual fact is that the average number of days the applicants had to wait was 23. If we exclude Sundays, it means that the Commission prepared these lists with an average of 20 days for each one, notwithstanding the fact that a vast amount of work has to be done for other departments. Other commissions may speak for themselves, but I am sure that Mr. Cooke was misinformed if he was referring to the local situation.

Let me say in conclusion that the merit system has not been perfected by any means; its improvement has been great and will be greater still. It is the one rock upon which the engineering departments in the public service must be erected and maintained.

ARTHUR M. SWANSON, Chief Examiner,
Philadelphia Public Service Commission.
City Hall, Philadelphia, Nov. 27, 1914.

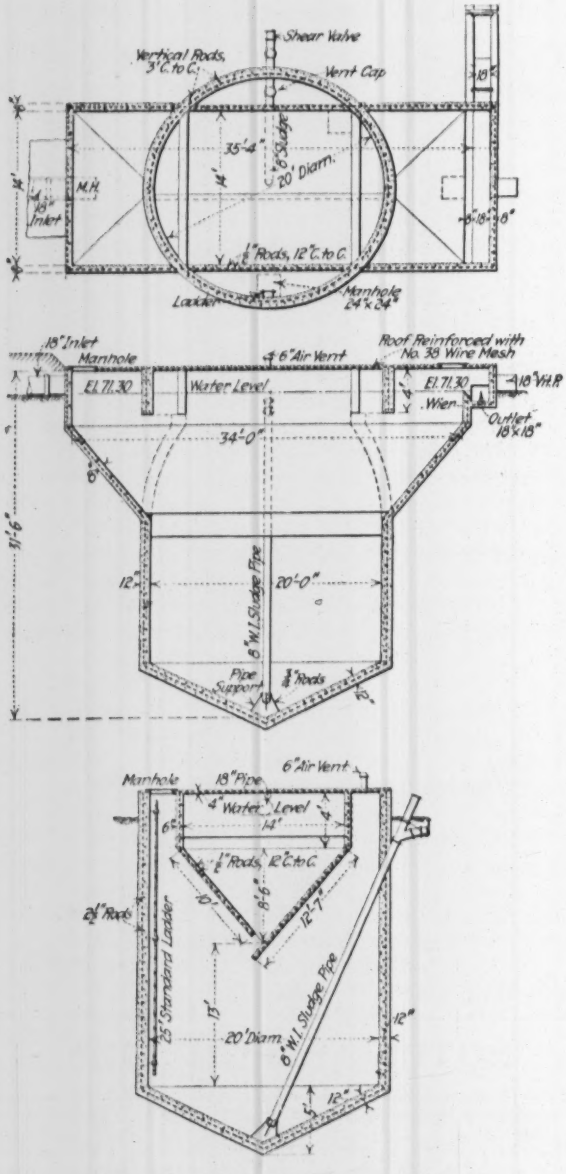
NOTES AND QUERIES

The Point Bridge Approach concreting plant described in our last issue, p. 193, was the plant at the north approach, while the photograph showed the steam-driven plant at the south approach. In consequence there was a slight lack of agreement between text and illustration, as some readers may have noticed.

Imhoff Sewage Tank, Waupun Wisconsin

The new Imhoff tank at Waupun, Wis., said to be the largest in Wisconsin, is designed to serve a population of 1500. The upper compartment or settling chamber has a capacity of 3050 cu.ft. The dimensions of the tank are shown by the accompanying illustrations. Provision is made for a duplicate tank and for filters in the future, but for the present the effluent from the tank is discharged over a series of steps into the Rock River.

The Imhoff tank and the new sewerage system of 6- to 18-in. pipe were designed by W. G. Kirchhoffer, of Madison, Wis., and their construction was supervised by E. S. Ela, of Rochester, Wis. The contractor was the Ideal Construction Co., of North Milwaukee, Wis. The Imhoff tank cost $2900 and the sewerage system $52,817.



IMHOFF TANK FOR WAUPUN, WIS.

Some Reasons for City Topographic Surveys

BY HUGH C. MITCHELL*

In considering the value of a good topographic map to the municipal engineer, the uses he may make of such a map can be grouped under four general heads: (1) In studying the feasibility of a project; (2) in securing the one best plan for his undertaking; (3) as a basis for preliminary plans and estimates; (4) city planning.

FEASIBILITY—There is no use which the city engineer can make of a good topographic survey map which will give him greater return in satisfaction, and perhaps in money, than being able to consider the feasibility of any and all projects proposed without having to send a party into the field for new surveys.

THE ONE BEST PLAN—With a good topographic map of the area being studied, the engineer has the material required for securing the *one best plan* for his undertaking—be it road building, sewer planning, or other public works. This may mean to the highway engineer a maximum grade of 3%, where without the map 4% would have been considered satisfactory. It costs more to build a street on the steeper grade, more to maintain it, and it takes more street to reach a given distance, since the available length of a street for buildings is not its slope length but its horizontal projection. To the sewer engineer it may mean a minimum length of sewer, a minimum amount of excavation, and a saving in cost. To all branches of the city engineer's office it means satisfaction and economy.

BASIS FOR PLANS AND SPECIFICATIONS—In using the topographic map in the office as a basis of preliminary plans and estimates, the engineer does away with the field-work of preliminary surveys. For the cost of making all preliminary surveys spread out over many years in a given area is substituted the cost of making one single complete topographic survey and map.

Figures are lacking to show on which side the balance is, but it may be assumed that for $1000 per sq.mi. a topographic map can be constructed which can be used with absolute safety for preliminary plans and estimates by all branches of a city engineer's office. It is a question if all the preliminary surveying required in a square mile of territory for each separate undertaking, spread out over many years, could be done for that sum, for $1000 will support one survey party for perhaps three months, or, say, one party each for the sewer and highway engineers for one month, and for the park and bridge engineers for one-half month each. Actual figures would, of course, show a wide range, varying with local conditions, but the economy of a single complete survey seems obvious.

A brief canvass of a number of cities having good topographic maps produces a unanimous opinion that such maps are of great value in municipal engineering work and are productive of real economy, saving many dollars of public funds.

CITY PLANNING—What is the expense of cutting down the "Hump" in Pittsburgh's downtown district, compared with what it would have been, say 25 years ago? H. F. Cory, of San Francisco, writes in the September *Proceedings* of the American Society of Civil Engineers:

> The topography and natural features of San Francisco are such that it could have been made one of the most beautiful

*Of Brown & Clarkson, Civil Engineers, Washington, D. C.

cities in the world. Unfortunately, like other places, it grew up "Topsy fashion" and the layout is rectangular quite regardless of the configuration of the land. There result grades as high as 22%. The opportunity which the great fire of 1906 presented for redesigning the most important part of the city was not utilized. The City Engineer's office recently stated that $26,000,000 was the cost of certain improvements, necessary under the circumstances, but which would have been entirely avoided had the city's planning been adjusted to the topography, as might have been done, and that this expenditure was but the beginning of a series which from time to time must be made.

How many other cities are there which might produce similar testimony? Can one doubt that there is a tangible saving, an actual economy, in having *the one best plan* the final plan, and that nothing goes farther to produce the one best plan than a good basic topographic survey and map?

The Need of a City Plan and of a City Topographic Map*

By Joseph W. Shirley†

In the correspondence which led up to this address, I suggested that whatever I might have to say to you might touch on the importance of a topographical map to a city as a basis for proper city planning.

But you will please understand that my references to City Planning are limited almost entirely to street-plan development, which is simply one phase of the big subject. The Topographical Survey Commission of Baltimore simply has jurisdiction over the street plan, but we feel that if we are able to provide the city with a well constructed framework—streets—then we shall have a very good basis for other forms of planning.

I have been really greatly interested in reading the admirable report of your [the Louisville] City Improvement Commission. Among the several passages in the report that struck me forcibly, this one appears:

> The more we study this problem, the more are we shocked to see the woeful disregard of common sense and good practice in the additions made to the city within the past few years.

Your committee also got to the gist of the matter when it recommended:

> You can no more build a city without a well considered plan than you could a building or a gown. In no case can one expect to reach a satisfactory result without a study of the relation of the component parts to the finished production.

I have remarked before in discussing civic betterments that it does seem odd that the separate elements embraced within city planning, such as buildings, railroads, municipal works of all character, are each studied and planned seriously and altogether scientifically. Yet, to the composite whole, there is the minimum of attention. In other words, the smaller things receive our most minute care and the largest thing that man has yet built, a city, is allowed to progress in the most haphazard and care-free way possible.

Out of the number of good recommendations which I read [in the Louisville report] there are two which fall, especially, under the topic on which I am speaking to you this evening. One is that you must have a good survey and map on which to base any plans for improvement, and afterwards you must endeavor to develop a *sensible* City Plan.

I note that your committee asks for $30,000 for the preparation of this map. Without giving the matter close scrutiny it would appear to me that this is hardly a sufficient sum. I, of course, do not know what your survey contemplates—the scale to which your map is to be made, the amount of detail to be shown, nor a great many other essential features necessary on which to base a proper opinion. And here I may emphasize the importance of accurate mapping. In Baltimore, if you will pardon the lack of modesty, we made an excellent survey and map. The map is on the scale of 200 ft. to 1 in., with contour intervals of 5 ft. It is made in square-mile sections, 38 of them, and shows all of what we consider essential details for the development of new areas as well as for the rearrangement of the older sections. The basic work for this map was most carefully done. A complete triangulation of the city, based on the general method used by the U. S. Coast & Geodetic Survey, was made; precise levels were established over the entire area, and now, after twenty years working on this map, and comparing it to those of other cities, I can truthfully state that I know of no point of importance which was neglected, nor do I think any methods of less refinement could have been adopted to have insured the same results.

Before the map was made Baltimore was confronted by two large civic problems, besides, of course, numerous ones of a lesser degree of importance. The larger ones were the development of a large rural area which had recently been annexed to the city and the planning for an entirely new sewerage system, both storm water and sanitary. Sensibly, I think, we first made a good map before taking any important steps along either of these lines. Since then we have been planning. We have not planned ideally, of course. We have had, as probably have had the officials of all American cities, great obstacles to overcome. These obstacles, when we boil them down, become almost invariably the selfishness of the individual property owner. Your City Improvement Commission has mentioned a similar hindrance. This, however, is being gradually overcome in Baltimore and you should not let it give you unnecessary concern in Louisville.

I note that your Commission grasps the true essence of city planning by considering the necessity for planning for the undeveloped sections of your city. This is something you can now do while you are, at the same time, giving study to conditions which need rectifying in your built-up and congested sections. The crux of the whole matter is, of course, that if you do not give proper attention to your growing sections they will soon be in as bad condition as are the older portions of your city, which were allowed to develop without care or attention. Allow me to return, figuratively, to Baltimore.

As I mentioned, just before our map was made we had annexed a considerable area to the city, about 31.94 sq. mi. Previous to the time of annexation, this territory had been studied according to the old-fashioned lights regarding the system of proposed streets, and the streets were for the most part marked by granite monuments at the northeast corners. Probably, needless to say, the line conformed to the old checker-board or gridiron ideas. Fortunately, however, we had a number of good routes of travel leading from the heart of the town to the outlying sections, and the old planners did adopt these routes in their plan of streets. It was realized, however, that the old county plan might not prove ideally satisfactory,

*Extracts from a paper read before the Engineers and Architects Club of Louisville, Ky., Oct. 20, 1914.

†Chief Engineer, Topographical Survey Commission, Baltimore, Md.

and so a Commission was appointed to study farther this territory and to draw up an official plan. This was all done, and since that time, namely, in 1898, we have worked on the Commission's plan of streets for the development of our suburban sections. The old plan, viewed from the light of modern practices, was far from ideal and it has been amended and changed so often that its originators would now hardly know their work.

I think, at one time, a great many of those having to do with the expansion of the street system in our larger cities felt that they could lay down a definite plan, adhere to it rigidly and by some as yet unexplainable method enforce the street-plan development on all property owners. Our experience in Baltimore has been that this was indeed a fanciful dream. We have not done it, though, on the whole, I think we have succeeded very well in carrying out the more important elements.

We rely principally on a law which states that the city cannot condemn and open a street nor accept the deed or dedication of any street the lines and grades of which do not conform to the established street plan. In other words, we cannot absolutely prevent property owners from laying out their streets along nonconforming lines, but we can and do refuse to grade, pave, lay water mains and sewers or provide lighting in the beds of such streets as are incongruous to the plan, and this, in itself, has had a marked stimulus in limiting haphazard layouts.

But in by far the larger area under control of the Topographical Survey Commission the street plan is developed through a compromise, give and take, between the city and the property owners. This is, of course, not ideal and no doubt the future will give us more stringent means of developing the street system in conformity with the ideas of the city and not along the lines best suited to the individual property owners.

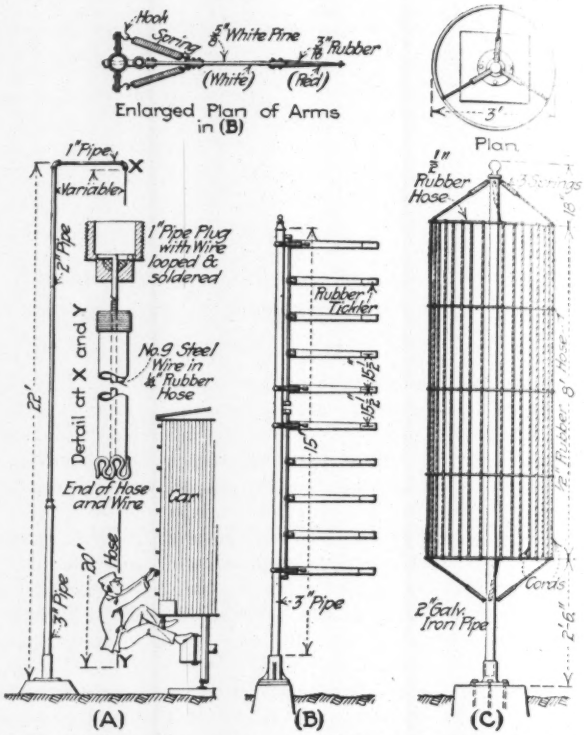
Telltales for Side Clearance on Railway Track

Bridges over railway tracks too low to clear a man standing on the roof of a freight car commonly have telltales or "ticklers" hung across the track some distance in advance of the bridge which will hit any forgetful man and warn him to lie down. Similar telltales are used to a limited extent to warn men of obstructions at the side of the tracks projecting into the normal clearance space. Three types of these side-clearance indicators are shown in the accompanying cut.

The one at the left consists of a steel pole with an arm from which is suspended a No. 9 steel wire incased in a ¼-in. rubber tube. The upper end of the wire is coiled in a pipe plug and soldered, and its lower end is looped to support the tube. The top of the tube is wrapped with a small wire soldered to the suspension wire. The wire and tube hang in the clearance line of the obstruction, and will be struck by a man riding in such position as to strike the obstruction. It is set far enough in advance to give the man time to assume a safe position.

The second design consists of a pipe post carrying vertical hinged rods, to which are attached light wooden blades with a rubber strip inserted in the end (or a double strip fitted over the end) of each blade, as shown. The blades have side springs hooked to arms on the post, so that they are easily pushed aside if a man strikes them. The post and arms are painted white and the rubber tips are painted red.

The third design has a vertical cylinder, composed of cords attached to rings of ½-in. rubber hose and hung from a post by springs in such a way that it will give



WARNINGS OR TELLTALES FOR OBSTRUCTIONS THAT ARE DANGEROUSLY CLOSE TO RAILWAY CARS

(A. Suspended wire encased in a rubber tube. B. Post with flexible arms. C. Cylinder of cords and hose. Not drawn to scale)

and partially revolve if struck. The cords are 3-strand tarred marlins.

These three designs have been tried on the Chicago, Burlington & Quincy R.R. None of them is considered entirely satisfactory, however, and further experiments are being made. The second design, as used on this road, has inserted rubber ends. This design has been tried also by the Baltimore & Ohio R.R., where the rubber ends are of the form shown in the cut.

The St. Louis Law on Quantity Surveying*

During the past year a committee of the Engineers' Club of St. Louis, Mo., prepared and caused to be introduced in the Municipal Assembly an ordinance creating the office of Quantity Surveyor. This ordinance was passed by both branches of the assembly and was approved by the Mayor last November, and is now law. The ordinance follows:

An ordinance to appoint certain persons as Quantity Surveyors.

Be it ordained by the City of St. Louis, as follows:

Sec. 1. The Mayor by and with the approval of the Council may appoint any number of competent persons, who shall be

*From the January "Journal of the Association of Engineering Societies."

skilled in building construction and estimating as quantity surveyors.

Sec. 2. Each quantity surveyor so appointed shall give a good and sufficient bond to the City of St. Louis in the sum of $10,000, conditioned that he will faithfully perform the duties of quantity surveyor under said appointment, which bond must be executed by the appointee, and at least two good sureties, to be approved by the Mayor and Council, and no such bond shall be approved unless each of the sureties thereon be the owner of real property assessed at not less than one-half the amount of the bond.

Sec. 3. Any person who may employ such quantity surveyor, and who may sustain loss or damage by reason of the negligence, incompetency or misconduct of such surveyor, shall be permitted to bring an action on the bond of such surveyor in his own name in any court having jurisdiction in the premises; provided, that any such action shall be brought within five years after the expiration of the commission of such surveyor.

Sec. 4. The quantity surveyors so appointed shall be commissioned and hold office for the term of four years from the respective dates of their respective commissions, and they shall charge for their services such fees as shall be agreed upon with the parties desiring their services, until such time as a joint committee from the Engineers' Club of St. Louis, the St. Louis Chapter of the American Institute of Architects and the Building Industries' Association shall recommend a definite schedule of fees for estimating different classes of structures, when the schedule of fees so recommended shall become the legal fees for quantity surveyors.

A bill requiring that all architectural and engineering plans of public work in the state be accompanied by a detailed list showing the quantity of each material used in the work, has been prepared by the committee for introduction in the state legislature during the present session. It is hoped to create a custom which will be extended to private work.

The committee of the club is now considering standard methods to be used in computing the quantity of each kind of material to be used in a structure

Annual Meeting of the Illinois Society of Engineers and Surveyors

The 30th annual meeting was held at the Leland Hotel, Springfield, Ill., with the President, John J. Harman (Peoria, Ill.), in the Chair, and a fair attendance of members, visitors and exhibitors. Apart from the usual series of papers and reports on technical matters, there was a brisk discussion as to engineers in the public service undertaking work in competition with engineers in private practice. A resolution was adopted that where engineers in salaried public positions undertake private work, it should be at rates commensurate with the value of their services.

The State Board of Health requested the support of the Society in the proposed establishment by the Board of an engineering department to look after matters of sanitation, sewage disposal, etc. The opinion was expressed that the field for such state engineering bodies should be largely educational and advisory and confined largely to the investigation of cases where engineering works are needed but where the communities do not appreciate the necessity of technical advice or are neglectful in calling for it.

It was recognized that the public should have the value of the experience and knowledge of high-class men in government employ in the various state boards and commissions, but that on the other hand care should be exercised that their work does not adversely affect engineers who are carrying on private practice. A resolution was passed indorsing the proposed action of the State Board of Health.

Several papers were read dealing with paving of various kinds. One by W. H. Kirchoffer (Madison, Wis.) advocated a concave instead of crowned street cross-section, and C. M. Powell (Chicago) advocated building concrete curbs as part of the concrete pavement, instead of separate from it. Geo. L. Harnsberger (Springfield) described the use of burned shale for paving park driveways, and G. E. Johnson (Falls City, Neb.) described an economical paving with thin square-edged brick.

The sewer system at Alton, Ill., was described by J. E. Schwaab (City Engineer), the work including pipe tunnels. A paper on the investigation of the artesian-well water supplies of Illinois was read by F. W. De Wolf (Illinois Geological Survey), a method of estimating the costs of steel and concrete bridges, based on the general use of standard designs, was described by C. F. Burch (State Highway Department), who showed a number of curves used in such estimates. This Department is now making a survey of all bridges within the State, and this has shown the necessity of adequate engineering supervision of highway bridge work.

A report of the Committee on Measures, Weights and Coinage strongly advocated the general use of the metric system and referred to the recent organization of the American Association for the Adoption of the Metric System.

The election of officers resulted as follows: President, W. S. Shields, Consulting Engineer, Chicago; Vice-President, Paul Hansen, Director of the State Water Survey, Urbana, Ill.; Secretary, E. E. R. Tratman, 1144 Monadnock Block, Chicago. The next meeting will be held at the University of Illinois, at Urbana, in January, 1916.

Repairing a Leak in an Unusual Reservoir

An old quarry bed has been used for a sedimentation basin at the Little Falls filter plant of the East Jersey Water Co., Little Falls, N. J. The basin is 315 ft. long, 115 ft. wide and 20 ft. deep as completed. The quarry in which the basin was built originally had an irregular depth of from 25 to 50 ft., but this for many years had been filled in to some 20 ft. from the surface with loose rock débris.

It was not known what the action of the filling would be and so no treatment was attempted before putting down the basin floor. Reinforced-concrete retaining walls were run around the edges of the quarry to serve as sides of the basin. A center wall with weirs was also built. The floor was made with a joint between the side walls and bottom slabs.

There was no appreciable settlement of the walls, but in one corner the floor settled as much as 4 in. and through the cracks there was a heavy outflow of water. The basin was drained, holes were drilled in this section of the floor and pipes were run to the surface for grouting. An enormous amount of grout was required to seal the fault. The cracks were closed with asphalt. Since the basin was put into use, there has been no further settlement or leakage.

Instructions for First-Aid Treatment*

Wounds That Bleed—Abrasions, Cuts, Punctures

Drop 3% alcoholic iodine into wound freely; then apply dry sterile gauze to wound and bandage it. Do not otherwise cleanse wound.

Severe Bleeding

Place patient at rest and elevate injured part. Apply sterile gauze pad large enough to allow pressure upon, above and below wound. Bandage tightly.

If severe bleeding continues apply tourniquet between wound and heart and secure doctor's services at once. Use tourniquet with caution and only after other means have failed to stop bleeding.

Nose Bleeding

Maintain patient in upright position with arms elevated. Have him breathe gently through mouth and not blow nose. If bleeding continues freely, press finger firmly on patient's upper lip close to nose or have him snuff diluted white wine vinegar into nose.

Injuries Which Do Not Bleed—Bruises and Sprains

Cover injury with several layers of sterile gauze or cotton, then bandage tightly. Application of heat or cold may help, other means are unnecessary. If injury is severe place patient at rest and elevate injured part until doctor's services are secured.

Eye Injuries—Except Eye Burns

For ordinary eye irritations flood eye with 4% boric acid solution. Remove only loose particles which can be brushed off gently with absorbent cotton wrapped around end of toothpick or match.

Do not remove foreign bodies stuck in the eye. In that case and for other eye injuries, drop castor oil freely into eye, apply sterile gauze, bandage loosely and go to doctor.

Fire, Electrical and Sun Burns

Do not open blisters. Use burn ointment (3% bicarbonate of soda in petrolatum) freely on sterile gauze applied directly to burn. Cover with several thicknesses of flannel or soft material, then bandage but not tightly.

Acid Burns

Thoroughly flush wound with water, then dry wound, apply burn ointment and bandage as above.

Alkaline Burns

Thoroughly flush wound with water, then flood with white wine vinegar to neutralize (dilute vinegar for alkaline eye burns), dry wound, apply burn ointment and bandage as above.

Dislocations

In case of dislocation of finger except second joint of thumb, grasp finger firmly and pull it gently to replace joint, then place finger in splint and bandage. In other cases rest dislocated part and secure doctor.

Fractures

Make patient comfortable and secure doctor's services at once. Avoid unnecessary handling to prevent sharp edges of broken bones tearing artery. If patient must be moved, place broken limb in as comfortable position as possible and secure it by splint.

Frost Bites

Rub with ice, snow or cold water; treat as "fire burns."

Chills and Cramps

Give patient 20 to 30 drops of Jamaica ginger in hot or cold water. If no improvement, send for doctor.

Internal Poisoning

Immediately secure doctor's services. Make patient drink large quantities of water, preferably warm, and make him vomit by sticking one's finger down his throat or by other means.

Heat Prostration

Give patient teaspoonful of aromatic spirit of ammonia in hot or cold water. In case body feels warm apply cold to it; if necessary give cold bath. In case body feels cold and clammy, apply heat to it and send for doctor.

Shock, Following Injury

In case shock is due to severe bleeding, control it first as directed under "severe bleeding" and summon a doctor.

Lay patient flat on back and keep him warm with blankets, hot-water bottles, etc., and provide plenty of fresh air. Let patient inhale fumes of aromatic spirit of ammonia. If fully conscious give patient hot drink or teaspoonful of aromatic ammonia in hot or cold water.

Asphyxiation or Electric Shock

Immediately free patient from electrical circuit, using every care to protect one's self against electric shock. Then if patient is unconscious, even if he appears dead, lay him on his belly with arms extended forward, turn his face to one side, remove false teeth, tobacco, etc., from his mouth and draw his tongue forward.

Inspiration; Pressure off

Expiration; Pressure on

Kneel, straddling patient's thighs, facing his head, and resting your hands on his lowest ribs. Swing forward and *gradually* bring weight of your body upon your hands and thus upon patient's back, then immediately remove pressure by swinging backward. Repeat this movement about twelve times per minute without interruption for hours if necessary, until breathing has been started and maintained (see illustrations).

Meanwhile send for a doctor, have patient's tight clothing loosened, keep him warm and provide plenty of fresh air. Do not give patient liquids by mouth until he is fully conscious.

*From a Bulletin of the Conference Board on Safety and Sanitation (National Affiliated Safety Organizations; M. W. Alexander, Secretary, West Lynn, Mass.) Copyright, 1914,

News of the Engineering World

Projected Sewage-Works for Johnstown, Penn.

Sewage treatment by means of Reinsch-Wurl screens and disinfection with liquid chlorine is proposed for Johnstown, Penn. We are informed by C. P. Collins, Sanitary Engineer of Johnstown, that a preliminary report on a collecting system estimated to cost $994,000 and on a disposal plant estimated to cost $105,000 has been submitted to the city council and to the State Department of Health. It is expected that a special election to vote on a bond issue will be held in the spring. On May 1 a more complete report will be submitted.

The population of Johnstown in 1910 was 55,482. The estimated population at present is 66,000. The disposal plant is designed to accommodate the population 15 years hence, which is assumed to be about 104,000. It provides for treating a maximum flow of 225 gal. per capita as compared with present minimum and average flows of 40 and 90 gal., respectively. The city already owns land for a disposal plant so located that the sewage can be brought to the site and discharged from the site into the Conemaugh River without pumping, provided screening and disinfection be adopted.

The tentative plans, which we understand have been submitted by the Sanitation Corporation of New York and Philadelphia, propose to make use of two screens, each 14 ft. in diameter, set at an inclination of 25°, the screen disk rotating at from 1 to 2 to 20 r.p.m. It is assumed that the screens will remove 50 to 60% of the removable solids from the sewage and will deliver these solids with a moisture content of about 80%. The screens would be of manganese bronze, ⅛ in. thick, perforated with V-shaped slots $\frac{1}{32}$x2 in. Each screen would require from 1 to 2 hp. to drive it, which would be supplied by variable-speed electric motors. In addition, auxiliary oil or gas engines would be provided for emergency use.

The amount of liquid chlorine used would be adjusted automatically to meet the varying volume of sewage, it being expected that five to six parts per million of available chlorine would be used.

For sludge disposal a high-temperature destructor would be provided, using oil as fuel and giving combustion temperatures of 2000 to 3000° F.

Of the estimated cost of $105,000 for treatment works, $57,000 would be for mechanical equipment and $48,000 for structural work. The daily operating cost, including labor, electric current, fuel and chlorine, is estimated at $9000 a year, to which should be added $6000 for capital charges, the latter charges being based on 4½% interest, 2½% depreciation on mechanical equipment and 1¼% depreciation on buildings. The operating charges are based on the plant being run during the daytime, only. During the low night-periods of flow it is the purpose to use the screens as *fixed screens.*

Estimates for Imhoff tanks were made, but the site would accommodate a plant large enough only to serve the city for 15 years, the sewage would have to be pumped, the effluent disinfected and the sludge burned just the same.

Guarding Against Colorado River Floods

To guard against the overflow of the Colorado River into the Imperial Valley at the time of the June floods, there has been inserted in the Sundry Civil Appropriation Bill introduced in Congress on Feb. 4, an item of $100,000, conditioned upon the provision of a like sum being paid into the Treasury of the United States by the Imperial Valley Irrigation District and upon the whole $200,000 being expended under the direction of the Secretary of the Interior. A report on the general subject of the protection of the Imperial Valley from overflows of the Colorado River was submitted by Gen. Wm. L. Marshall, Consulting Engineer to the Secretary of the Interior, on Jan. 2, 1915 (H. R. Doc. 1476, 63d Congress, 3d Session). The floods of 1914 threatened the Imperial Valley, but the danger was averted by protection work done with federal and local funds. A large highly productive irrigated area in the Imperial Valley is liable to have its water-supply cut off at every serious overflow of the Colorado.

Western Society Replies to Attacks on Engineers

A recent report upon the water-power development on the Chicago Drainage Canal, prepared by an engineering commission appointed by the Sanitary District of Chicago (and reviewed in our issue of Dec. 3), criticized the present plant at Lockport as being out-of-date and of low efficiency. On this account, the engineers composing this commission have been attacked severely by trustees of the District and members of the City Council, implications being made as to their personal and professional integrity. The Western Society of Engineers on Feb. 1, adopted resolutions, abstracted below, protesting against such attacks, which were based on the fact that the conclusions of the engineers were not what had been expected or hoped.

The public welfare is vitally affected by any pronounced attempt on the part of public officials to suppress, conceal, distort or overawe the carefully-prepared opinions of experienced engineers reporting on public questions for the public interest.

This Society views with regret this public attempt to abuse men who were apparently trying to do their duty to the public in setting forth facts as they found them, and the Society would point out (for the benefit of the public officials who have been conspicuous in this controversy) the following proper relations with engineering advisers, which it wishes to emphasize as vitally affecting the public welfare:

(1) An engineer's first duty to his client is to tell him the truth, no matter where it may lead or how unpalatable it may be.

(2) Engineering and engineering economics are subject to natural law, which cannot be altered to suit the whims of human nature.

(3) The most serious disgrace that can come to an engineer is to conceal, pervert or distort natural and economic laws, either to please a client or temporarily to advance his own interests, and so ultimately lead his client into difficulties.

(4) An experienced engineer of standing ranks as a confidential professional adviser, who feels keenly his responsibilities and whose integrity and conscientiousness, when properly established, should be appreciated and upheld by his client.

Another Record in the Rogers Pass Tunnel

The November figure of heading advance in the Canadian Pacific Ry. Rogers Pass tunnel was broken in January by an advance of 932 ft. in the west pioneer heading. The rock was slate. A. C. Dennis, Superintendent for Foley Bros., Welch & Stewart, the contractors, gives the January figures as follows:

Heading	Progress, Ft.	Rock
E. center	443	Schist and quartzite
E. pioneer	594	Schist and quartzite
W. center	701	Slate and quartzite
W. pioneer	932	Slate

A Break in an Old New York Water Main

The break in the old 30-in. Croton water-supply main at Eighth Ave. and 42d St., New York City, noted on p. 237 of ENGINEERING NEWS, Feb. 4, 1915, was finally located at a nearby bend and was found to be a 6-ft. split.

The pipe (cast-iron)) though nearly 60 years old, is reported as found in perfect condition, aside from the break, and department engineers hold that the break is no reflection on the durability and reliability of cast-iron pipe. The investigation showed that the break was probably due to carrying a part of the load and vibration of street-car tracks above, as a wire-conduit structure rested on the pipe with track foundations superimposed and no soil cushion between.

The pipe was a part of the original Croton water-supply system and was laid from the receiving reservoir at 81st St. down Eighth Ave. to 42d St., and thence to the old distributing reservoir at Fifth Ave. and 42d St., about 1855.

The Boiler Explosion on the United States cruiser "San Diego" off the coast of Mexico, on Jan. 21, has caused the death of nine of the crew. Four were killed at the time of the explosion and five of the nine seriously injured have since died.

The Butting Collision of a Freight Train with a Street Car at Fair Oak, Ohio, Feb. 1, caused the death of three and injuries to a dozen more employees and passengers. Both train and trolley car were on the same track. It is reported that the freight train had orders to wait on a siding for the car, and that the car was ahead of time and passed the siding. The accident occurred during a heavy fog.

A Rear Collision on the Ninth Ave. Elevated Line, at 50th St., New York City, at 8:30 a.m., Feb. 6, tied up all traffic on the Ninth and Sixth Ave. lines for several hours. One motorman and several passengers were injured. A short-circuit and the wooden cars caused a fire, to extinguish which it was necessary to call out the fire department.

A Fire in a Cold-Storage Plant at Fort Wayne, Ind., Feb. 2, required a six-hour fight by the local fire department to extinguish. The fire was started by a gasoline torch which ignited gasoline in a 5-gal. tank in the basement. Several kettles of tar being used to repair the 3-in. cork floor were soon ignited. The building was equipped with automatic sprinklers, but the water only spread the burning oil [illegible] ing of the ammonia pipes increased the firemen's di[illegible]

The Bursting of a 36-In. Water Main caused a s[illegible] of the entire Bethlehem Steel Co. plant, at South Be[illegible] Penn., Feb. 4. The main was used to carry the wate[illegible] of the works from the pumping station on the Lehig[illegible] The following is from an official statement by the c[illegible] "The bursting of the pipe was caused by leakage from [illegible] pipes above the large water main, which washed [illegible] ground surrounding the main, causing the large pipe t[illegible] and give way. As a result of the water-supply bein[illegible] off from the plants, there was some damage to wate[illegible] apparatus both at the blast furnaces and open-hearth [illegible] ments. Fortunately, the superintendents of all the depart[illegible] ments were on hand and took the necessary steps to p[illegible] any serious damage. It was equally fortunate that the com[illegible] pany had just completed a new 42-in. water main, by which they were enabled to by-pass the break in the 36-in. main and get the water through the new line into the Lehigh plant. It was only a matter of a few hours before the new water main was in operation and steam again raised."

Plans for a Municipally-Owned Garbage-Reduction Plant for Detroit, Mich., have been prepared by Smith, Hinchman & Grylls, architects and engineers, of Detroit. No contracts have yet been let, but possibly some action to this end will soon be taken. The plant will have a capacity of 20 tons of green garbage per hour, and in general will conform to recent practice.

A River Terminal Conference, composed of governors and delegates from states along the Mississippi River is to be held at the Planters Hotel, St. Louis, Mo., Feb. 18 and 19. The purpose is to consider a report on improvements of facilities for vessels and freight handling at river ports. Governor Eberhart of Minnesota is Chairman. Arrangements are in charge of Wm. F. Saunders, Secretary and Manager of the Business Men's League of St. Louis, 510 Locust St., St. Louis, Mo.

State Registration of Structural Engineers is under investigation by the legislative committee of the Western Society of Engineers. Under the Illinois law, all plans for buildings must be signed by an architect holding a state license, and an engineer who prepares designs for any type of building has to get an architect to sign the plans. The committee is investigating whether it would be advisable to promote legislation for the licensing of structural engineers, who could thus be responsible for their own plans. The committee's report will be considered by the Society before any action is taken.

PERSONALS

Mr. H. F. Bickell has been appointed Inspector of Transportation of the Texas & Pacific Ry., with office at Dallas, Tex.

Mr. James D. Welsh, General Superintendent of the Colorado & Southern Ry., at Denver, Colo., has resigned, effective Mar. 1.

Mr. W. E. Williams, General Superintendent, has been made General Manager of the Missouri, Kansas & Texas Ry. Co., with headquarters at Parsons, Kan.

Mr. A. G. Wulff has opened an office at 309 Provident Bank Bldg., Cincinnati, Ohio, for the general practice of civil engineering, specializing in municipal work.

Mr. Arthur C. Vicary, formerly of Lorain, Ohio, has been appointed Sales Manager of the new steam shovel department of the Ball Engine Co., of Erie, Penn.

Mr. A. S. Baldwin has resigned as Manager of the Best Manufacturing Co., which has recently been absorbed by the Kennedy-Stroh Corporation, Pittsburgh, Penn.

Mr. W. A. Webb, General Manager of the Missouri, Kansas & Texas Ry. Co., has been appointed Vice-President, with headquarters at Dallas, Tex. He will be succeeded by W. E. Williams.

Messrs. O. J. Lehrack and J. H. Sherman, formerly with the Trussed Concrete Steel Co., Youngstown, Ohio, announce the formation of the Lehrock Contracting & Engineering Co., Kansas City, Mo.

Mr. F. A. Molitor, M. Am. Soc. C. E., Consulting Engineer, 35 Nassau St., New York City, expects to sail in a few days for Brazil to make an examination of the Brazil Railways for the Receiver, Mr. W. Cameron Forbes, of Boston, Mass.

Mr. William McIntyre has resigned as Highway Engineer of the Cheltenham (Penn.) Board of Township Commissioners. He will be succeeded by Mr. William S. Wolfinger, who will resign his present position with the State Highway Department.

Mr. J. W. Fletcher, Road Superintendent of the Carolina & North Western Ry., has been appointed Engineer in Charge of Valuation, Construction, Betterment, Inspection, Tests and Standards, with headquarters at Chester, S. C. His former position has been abolished.

Mr. Lewis Warrington Baldwin, Superintendent of the Kentucky division of the Illinois Central R.R., has been made General Superintendent of the Illinois Central R.R. and Yazoo & Mississippi R.R. lines south of the Ohio River, with headquarters at New Orleans, La.

Mr. T. W. Fatherson, Assistant Engineer of the Chicago, Rock Island & Pacific Ry., at El Reno, Okla., has been made Engineer of Maintenance-of-Way of the Chicago Great Western R.R., succeeding Mr. C. Millard, resigned. His headquarters will be at Des Moines, Iowa.

Mr. R. C. Andrews, Superintendent of the Eastern division of the Texas & Pacific Ry., at Marshall, Tex., has been made General Superintendent of that railway, with headquarters at Dallas, Tex. Mr. William Lynch, Superintendent of the New Orleans division, will succeed Mr. Andrews.

Mr. E. S. Koller, Assistant General Manager of the Chicago, Burlington & Quincy R.R. lines west of Omaha, has been appointed General Manger, to succeed Mr. James D. Welsh, General Superintendent of the Colorado & Southern Ry., Denver, Colo., resigned as noted elsewhere.

Mr. William Gibson, who is connected with the Waterous Engine Works Co. of St. Paul, Minn., was tendered a testimonial banquet on Jan. 30, at the St. Paul Commercial Club. Mr. Gibson was born at Hamilton, Ohio, Sept. 4, 1838. He has been in the service of the Waterous Co. since he was 15 years old.

Mr. J. Leonard Replogle has resigned as Vice-President and General Manager of Sales of the Cambria Steel Co., Pittsburgh, Penn., to become Vice-President and General Manager of Sales of the American Vanadium Co., Pittsburgh. Mr. Replogle has been in the employ of the Cambria Steel Co. for many years. He will assume his new duties about Mar. 1 and will have offices in New York and Pittsburgh.

Dr. Charles Edward Guillaume, of Sèvres, France, has been awarded the John Scott Legacy Medal and Premium by the City of Philadelphia, Penn., on the recommendation of the Franklin Institute of that city, for his alloy invar. Invar has found a wide application in meteorology and horology. In the former it is particularly useful for secondary standards of length. Dr. Guillaume has done a large amount of research work in connection with iron-nickel alloys, in the course of which he also discovered platinite.

Mr. Edward M. Hagar, M. Am. Soc. M. E., has resigned as President of the Universal Portland Cement Co., of Chicago, and will assume the presidency of a new company which he is forming to acquire a chain of portland cement plants covering a large part of the United States. The new company will be located in Chicago. Mr. Hagar graduated from the Massachusetts Institute of Technology in 1893, and received a post-graduate degree from Cornell University in 1894. He organized and conducted the business of Edward M. Hager & Co., of Chicago, acting as sales representative for machinery manufacturers, and in 1907 he founded the Cement Products Exhibition Co.

Mr. Allan C. Southern, Judge of the Circuit Court of Missouri, has been appointed County Surveyor of Jackson County, Mo., to succeed the late Rowland T. Proctor. The appointment was made, it is reported, entirely without solicitation, by Governor Major, because, as he said: "I wanted a man of executive ability, upon whose honesty I could implicitly rely, to administer the affairs of the office." The appointment has aroused much opposition among the engineers of the state, as Jackson County, which includes Kansas City, is one of the most important counties in the state. A resolution was adopted Feb. 4, by the Engineers Club of Kansas City, protesting against the appointment of any man not an engineer, when there are many men who are engineers eminently qualified to fill the office.

Mr. B. F. Affleck, General Sales Agent of the Universal Portland Cement Co., of Chicago, Ill., a subsidiary of the United States Steel Corporation, has been elected President of that company, to succeed Mr. Edward M. Hagar, M. Am. Soc. M. E., resigned, as noted elsewhere. Mr. Affleck entered the service of the Illinois Steel Co. in 1896 and for several years represented the cement department of the company at St. Louis. When the Universal Portland Cement Co. was incorporated in 1906 to take over the cement business of the Illinois Steel Co., he became General Sales Agent. He has been a pioneer in promoting the use of concrete as a paving material Mr. Affleck is Vice-President of the Cement Products Exhibition Co., under whose management the annual cement shows have been held in Chicago.

OBITUARY

John Ross, one of the best known contractors in Canada, died at Montreal, Que., Feb. 3. He was born in Montrose, Scotland, and came to Canada as a young man. He became a member of the firm of McDermott & Ross, who undertook many large contracts in the construction of the Canadian Pacific Ry. in the West. Subsequently he was associated with many important railroad enterprises in Quebec and Ontario, and also had extensive contracts on the second Welland Canal. Mr. Ross left two daughters.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN CONCRETE INSTITUTE.
Feb. 9-12. Convention at Chicago, Ill. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

CHICAGO CEMENT SHOW.
Feb. 10-17. At Chicago. Secy., J. P. Beck, Universal Portland Cement Co., Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 15-16. Annual convention at Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 15-17. Annual meeting at New York City. Secy., Bradley Stoughton, Engineering Societies Building, New York City.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Feb. 15-20. Annual convention at Detroit, Mich. Secy., Will P. Blair, Engineers Building, Cleveland, Ohio.

IOWA ENGINEERING SOCIETY.
Feb. 17-19. Annual meeting; at Iowa City. Secy., S. M. Woodward, Iowa City, Iowa.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY.
Feb. 19-20. Annual meeting, at St. Paul, Minn. Secy., George H. Herrold, City Hall, St. Paul, Minn.

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION.
Feb. 24, 25. Annual meeting at Indianapolis, Ind. Secy., Dr. W. F. King, State Board of Health, Indianapolis, Ind.

ILLINOIS WATER SUPPLY ASSOCIATION.
Mar. 9-11. Annual convention at University of Illinois. Secy., Edward Barlow, Urbana, Ill.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 16-18. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago, Ill.

Iowa State Drainage Association—The annual meeting will be held in Webster City, Iowa, Feb. 25 and 26. The Secretary is M. F. P. Costelloe, Ames, Iowa.

National Lime Manufacturers' Association—The officers for 1915 have been elected as follows: President, W. E. Carson, Riverton, Va.; Secretary, Fred K. Irvine, Chicago, Ill.

American Society of Agricultural Engineering—The following officers have been elected for 1915: President, H. H. Musselman, East Lansing, Mich.; Secretary-Treasurer, F. M. White, Madison, Wis.

Idaho Society of Engineers—The following officers were elected at the annual convention Jan. 26 to 28: President, Barry Dibble, Minidoka, Idaho; Secretary and Treasurer, Ira F. Shaffner, Boise, Idaho.

Seattle Association of Members of the American Society of Civil Engineers—The annual meeting was held at the College Club, Seattle, Jan. 25. R. H. Ober, Superintendent of Buildings, city of Seattle, was elected President and Carl H. Reeves, Construction Engineer of the Puget Sound Traction Light & Power Co., was elected Secretary-Treasurer.

Iowa Engineering Society—The 27th annual meeting will be held at Iowa City, Feb. 17, 18 and 19. The program includes papers on brick paving, cemetery platting, testing concrete, city planning, reports of the various standing committees on water supply, sewerage, factory engineering, structural engineering and legislation. The President is Prof. W. G. Raymond of the State University of Iowa, and the Secretary J. H. Dunlap, Iowa City.

American Road Builders Association—The annual meeting was held in New York City, Feb. 5. The report of the executive committee showed a substantial gain in membership during the past year. The reports of the committees on standards and on legislation were read and accepted, and will be printed in the "Annual Proceedings." After the conclusion of the meeting the members and guests adjourned to

Rector's restaurant, where an excellent dinner and impromptu addresses were made by the retiring President, W. A. McLean, of Toronto, Ont., the President-elect, Geo. W. Tillson, Consulting Engineer to the Borough President of Brooklyn, N. Y., and others. Besides Mr. Tillson, the following officers were elected: First Vice-President, A. W. Dean, Chief Engineer, Massachusetts Highway Commission; Second Vice-President, Austin B. Fletcher, State Highway Engineer of California; Third Vice-President, S. Percy Hooker, State Superintendent of Highways of New Hampshire; Secretary, E. L. Powers, Editor of "Good Roads"; Treasurer, W. W. Crosby, Consulting Engineer, Baltimore, Md. H. M. Waite, City Manager of Dayton, Ohio, was elected a director.

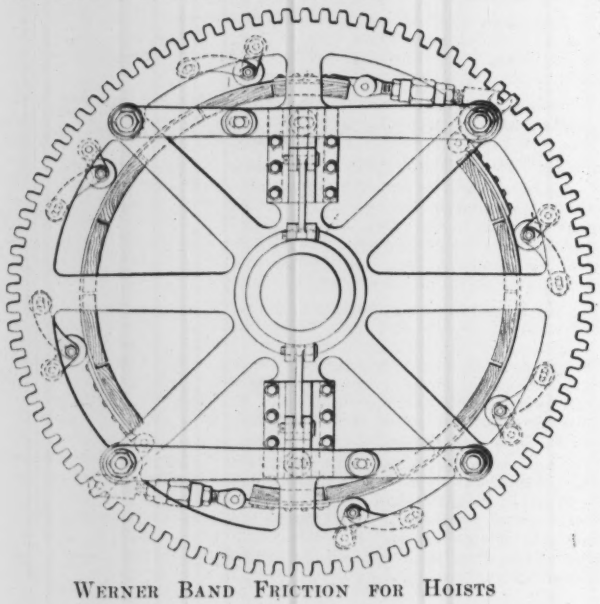
American Institute of Electrical Engineers—The annual midwinter convention of the Institute will be held Feb. 17 to 19. The program will be of a general nature. Two sessions will be under the auspices of the transmission committee; one of these will be devoted to the discussion of impact testing of high-tension insulators; the other to miscellaneous subjects connected with high tension work. Another session will be devoted to papers provided by the electrophysics, electric lighting and mining committees. The session on Friday morning will be devoted exclusively to the subject of electrical precipitation of fumes, smoke, dust, etc., and several papers will be presented dealing with the historical, theoretical and practical aspects of this subject. It is expected that a demonstration of electrical precipitation will be given, and two reels of motion pictures showing the operation of some Western installations will be shown. The last technical session of the convention will be devoted to the subject of application of electric motors, and a number of prepared discussions will be presented giving the characteristics of each type of motor which govern its application to various kinds of work. The session on Wednesday evening will include addresses by a number of prominent engineers on the general subject of the status of the engineer.

On Thursday evening a dinner-dance will be held at the Hotel Astor. Thursday afternoon will be devoted to inspection trips to points of engineering interest.

Appliances and Materials

Band Friction for Hoists

A band- or strap-friction clutch has been designed by T. O. Werner, Chief Engineer of S. Flory Manufacturing Co., of Bangor, Penn., to replace the usual cone friction on heavy-duty hoists. This company is now building hoists, equipped with this friction, for mine duty, drag-line operation and dredging. It is claimed to be well adapted for two-speed drag-line drums (where slow speed is needed for scraping and high for drawing the bucket in to dump), or for hoisting on planes where there is a light and heavy grade. In these machines, there are two friction rings on the main drum, differently geared to the engine shaft.



WERNER BAND FRICTION FOR HOISTS

This band clutch transmits its load directly from the gear to the friction ring on the drum, eliminating torsional stress in the drum shaft. The clutch is locked with the friction surfaces in or out of contact. The friction band is in halves connected by turnbuckles and short double-crank arms on rocker shafts extending through the gear. Keyed on each rocker shaft is a long lever with a second lever toggle-connected between the first and the gear. Each second long lever is pinned to a crosshead in radial guides on the gear. From the crosshead, two radial toggle links run to a sleeve on the drum shaft. To operate the clutch, the sleeve is moved along the shaft (by hand mechanism or by a steam or air cylinder under the operator's control); this moves the crosshead in or out, giving a corresponding motion of the long levers and turning the crank-arm links in the friction band to loosen or tighten the band on the friction ring.

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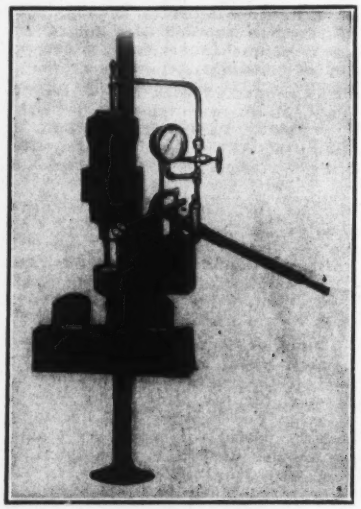
30-Ton Hydraulic Bending Machine

The press shown in the accompanying illustration was recently designed by the Hydraulic Press Manufacturing Co., of Mount Gilead, Ohio, as a pipe bender, but is being put out for miscellaneous bending operations in construction, railroad and general shops. The machine is of steel throughout. The C-frame and bed are cast in one piece; the hydraulic cylinder is received in a ring on the top of the C-frame so that it may be keyed into any desired position. The ram (6-in. diameter and 9-in. run) is forced down by a ⅝ x3½-in. hand plunger pump, with reservoir base, bolted to the frame; a maximum pressure of 30 tons is possible; there is a rack and pinion on the ram for quick lowering or raising; if the ram is moved by this, the cylinder fills out of the reservoir. The bed is 27 in. long and will take material 8 in. wide. Bending blocks are removed by merely lifting out of the bed notches.



NEW HYDRAULIC BENDING MACHINE

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The Goulds Multi-Stage Centrifugal Pumps

A line of multi-stage centrifugal pumps is now being put on the market by the Goulds Manufacturing Co., of Seneca Falls, N. Y., this company never before having manufactured multi-stage pumps. The new design shows its principal difference from other multi-stage centrifugals in having a lateral discharge of water through the diffusion vanes after leaving the impeller. This allows a smaller casing and somewhat less floor space for a pump of given service and speed. The design has other features, now familiar, such as horizontally divided casings and bearings. The smaller machines of the new line have their impellers independently balanced against thrust and the shafts carry thrust bearings also. The larger units have an automatic internal balancing disk and external thrust bearings are entirely dispensed with. The units are designed with from two to five stages according to service conditions. The sizes range from 4 in. discharge and suction to 8 in., and the capacities run from 200 to 1500 gal. per min.

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Wood Paving Blocks for Indoor Floors

The standard street-pavement creosoted wood block has frequently been used for factory and warehouse floors, but it is heavier than usually needed. To meet the increasing demand for a special block for this purpose, the American Creosoting Co., of New York City, has produced what are called "Brownie" blocks, which are 5 to 10 in. long, 2 to 3 in. wide and only 2¼ in. deep. The necessary impregnation of preservative is less and a better quality of oil is used to prevent bleeding (which is particularly liable to occur when standard street-paving blocks are used indoors). The blocks can be made so free from moisture that contraction of the indoor pavement from drying gives no trouble.